# DARCOM METAL REMOVAL WORKING GROUP

# 1983 ANNUAL REPORT

PREPARED FOR

DARCOM DIRECTORATE FOR MANUFACTURING TECHNOLOGY
ALEXANDRIA, VIRGINIA 22333

BY

USA INDUSTRIAL BASE ENGINEERING ACTIVITY
MANUFACTURING TECHNOLOGY DIVISION
ROCK ISLAND, ILLINOIS 61299

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This document summarizes the activities of the DARCOM Metal Removal Working Group for 1983. It contains an analysis of the metal removal Manufacturing Methods and Technology (MMT) program and outlines recommendations for technology areas which should be addressed in future metal removal projects. Also, included are summaries for all metal removal projects planned or funded from FY 70 through FY 85.

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DEPARTMENT OF THE ARMY
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ROCK ISLAND, ILLINOIS 61299

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1. Reference DARCOM-R 15-21, DARCOM Metal Removal Working Group, dated 3 September 1976.

2. The Metal Removal Working Group (MRWG) Annual Report summarizes the activities of the MRWG for 1983 and presents their recommendations for metal removal technologies to be pursued in future Manufacturing Methods and Technology (MMT) projects. The Report also contains a summary of all metal removal MMT projects initiated since 1970, with each project categorized according to a technology thrust area. Funding data is summarized for each major thrust area and for completed, active, and planned projects.

3. Comments on this Report are welcomed and should be sent to the Chairman of the MRWG, Mr. Alan Peltz, US Army Industrial Base Engineering Activity, DRXIB-MM, Rock Island, IL 61299.

4. Until a limited supply is exhausted, additional copies of the report may be obtained by contacting Mr. Peltz. Copies may also be obtained by sending a written request to the Defense Technical Information Center, ATTN: TSR-I, Cameron Station, Alexandria, VA 22314.

FOR THE DIRECTOR:

JAMES W. CARSTENS
Chief, Manufacturing Technology Division

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# INTRODUCTION AND BACKGROUND

The Metal Removal Working Group was formally established by DARCOM in 1976. At that time, several observations could be made concerning the Army's Manufacturing Technology Program. During the 1960's the Army had pursued proportionately more work in the area of metal removal and sponsored considerable work in establishing applications for numerically controlled machine tools. In the 1970's this work expanded to include the application of numerical control to processes other than metal removal, computer-aided manufacturing became the technology of interest, and there was a corresponding reduction in the funding of efforts undertaken to improve metal removal operations. At the same time, net and near net shape processes were being emphasized, thereby contributing further to the downward pressure on metal removal funding levels.

By 1977, only three percent of the total Manufacturing Technology Program was being directed toward metal removal technology and it had become clear that a forum was needed to focus attention upon the low level of Manufacturing Technology associated with metal removal processes and to coordinate the DARCOM Metal Removal Program. The Metal Removal Working Group was therefore established to coordinate metalcutting activities at the operational level and serve as a means of exchanging information among Army activities relative to metalcutting efforts, to identify significant metalcutting problems, to recommend metalcutting efforts with high potential payoff, and to provide long range plans for the development of metalcutting technology.

## 1983 ACCOMPLISHMENTS AND 1984 PLANS

Activities of the DARCOM Metal Removal Working Group for 1983 may be summarized as follows:

- Developed plans for an End-of-Project Presentation for TACOM MMT Project 4XX 5090 - Improved and Cost Effective Machining Technology.

- Developed plans for presentation of Kennametal's standarization Program at the Aviation Systems Command, Rock Island Arsenal, and Watervliet Arsenal.

- Solicited article describing Kennametal's standardization Program for January 1984 issue of Manufacturing Technology Bulletin.

- Sponsored briefing by Metcut concerning their unsolicited proposal - Centralized Machining Technology Data Base.

- Completed evaluation of Metcut's unsolicited proposal and provided a negative response to Metcut.

- Completed evaluation of Bergman, Inc. unsolicited proposal - Bergman Vertical Machine System - and provided a negative response to Bergman.

- Reviewed Lawrence Livermore National Laboratory's proposal for a CNC Machine Tool Tester.

- Developed plans for 1983 MRWG annual meeting, to include attendance at the final review of the Advanced Machining Research Program, the end-of-contract debriefing for Air Force MMT Project, "Production Machinability Data and Data Base Program," and a Kennametal "Standardization Program" presentation.

Metal Removal Working Group plans for 1984 include the following:

- Assist in developing an agenda and obtaining speakers for a Metal Removal Conference to be sponsored by the Metals Subcommittee of MTAG.

- Develop a forum for the exchange of information with the National Bureau of Standards and become familiar with NBS's Automated Manufacturing Research Facility.

- Revise and resubmit DARCOM-R 15-21 to DRCMT for staffing and publication.

- Develop plans for a MRWG meeting to be held in conjunction with the end-of-project presentation for TACOM MMT project 4XX 5082, "Flexible Machining System, Pilot Line for TCV Components."

- Develop plans for a MRWG meeting to be held in November 1984 in order to provide for an in-depth review of each command and arsenal's metal removal program by the individual MRWG members.

- Develop plans for the assignment of a MRWG member to one or more technical councils of the Society of Manufacturing Engineers in order to provide feedback to the membership relative to metal removal related technologies.

## ANALYSIS OF METAL REMOVAL MMT PROGRAM

In order to facilitate review and analysis of the metal removal program, projects were categorized using a thrust area scheme developed by the Metals Subcommittee of the Manufacturing Technology Advisory Group, shown in Figure 1. As can be seen from Figure 1, this thrust area scheme represents a pictorial overview of the technologies associated with the metal removal program. It was used to provide a basis for discussions of the metal removal program and for the development of recommendations for future technologies to be pursued in the metal removal MMT program.

Figure 2, "Overview of Total Army and Metal Removal MMT Program," shows funding for the total MMT program and for metal removal related projects from FY70 through FY85. For each of these years, the metal removal program is also depicted as a percentage of the total Army MMT program. As can be seen from Figure 2, the funding for metal removal projects was maintained at a fairly low level from FY70 to FY78, averaging approximately $750,000 per year - slightly over one percent of total Army MMT program for those years. Since FY79, funding for metal removal related projects has averaged approximately six million dollars - seven and one-half percent of the total Army MMT program for those years. Expressed as a percentage of the total MMT program, metal removal related project funding peaked at 18.9 percent in FY83. Based upon current planning data, it is projected to be five and one-half percent of the total MMT program for FY84 and FY85.

Figure 3, "Metal Removal Thrust Area Summary," shows the funding levels for the major thrust areas associated with the metal removal program. It has been divided into three sections in order to show data for completed, active, and planned projects.

As can be seen in Figure 3, 38 percent of all metal removal projects planned or funded since FY70 are currently active, on the basis of dollars, with 27 percent of the total program since FY70 completed and 35 percent being planned for FY84 and FY85.

Two major thrust areas, "Improved Metal Removal Rates" and "Improvement of Current Process Technology," account for 69 percent of the total metal removal program. These major thrust areas include both traditional and non-traditional machining processes applied to a wide variety of manufacturing operations employed in the production of Army materiel, and a wide range of projects designed to improve the overall efficiency of various manufacturing operations.

The third largest metal removal thrust area is "Computer Integrated Manufacturing Systems." Projects included in this area which were reviewed by the Metal Removal Working Group are those computer related projects which contain elements of an integrated or flexible manufacturing system and emphasize the development or improvement of machining operations related to a specific end item category. As can be seen from Figure 3, this thrust area has grown significantly since FY70 and now

# Metal Removal Thrust Areas

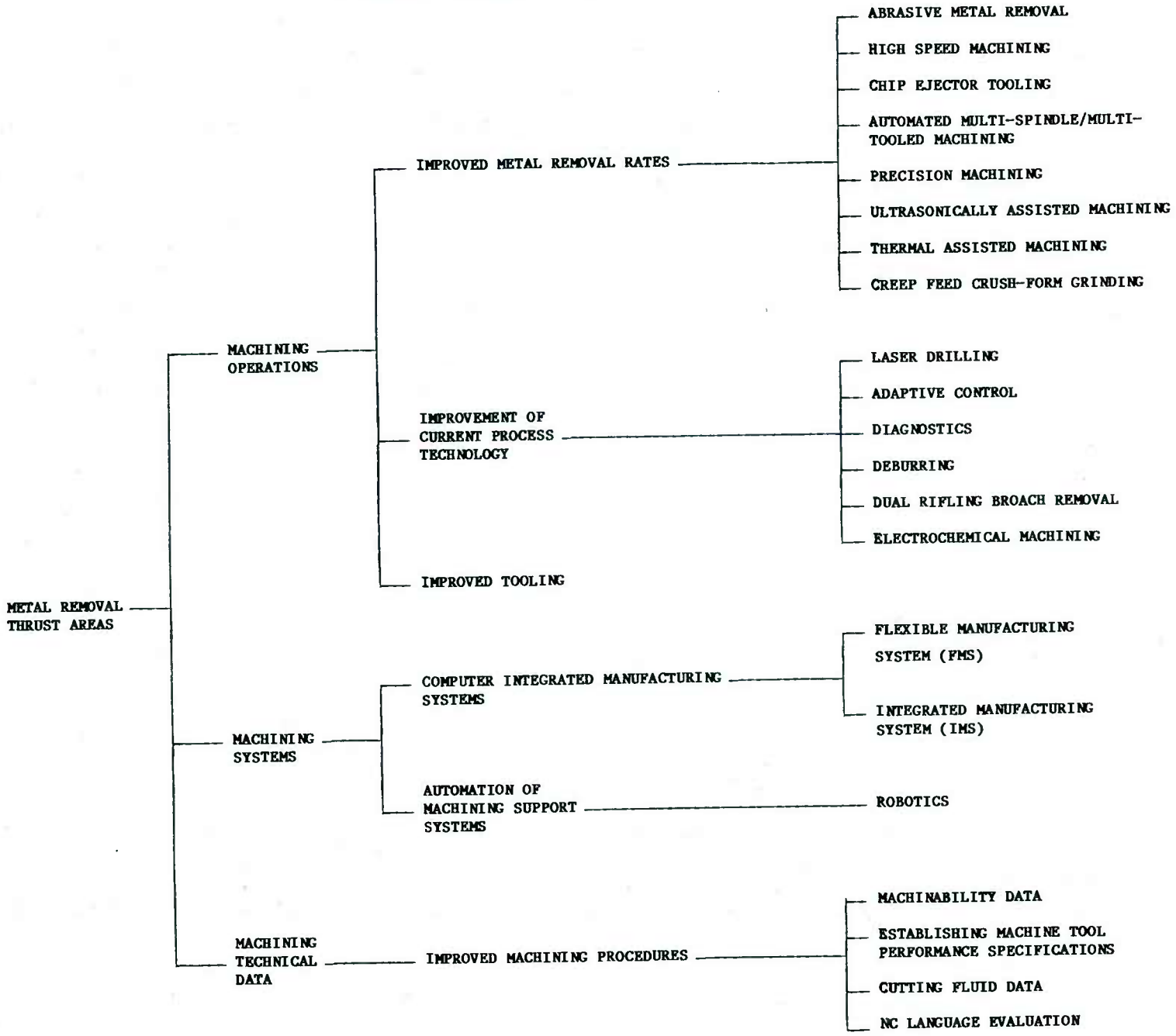


FIGURE 1. METAL REMOVAL THRUST AREAS.

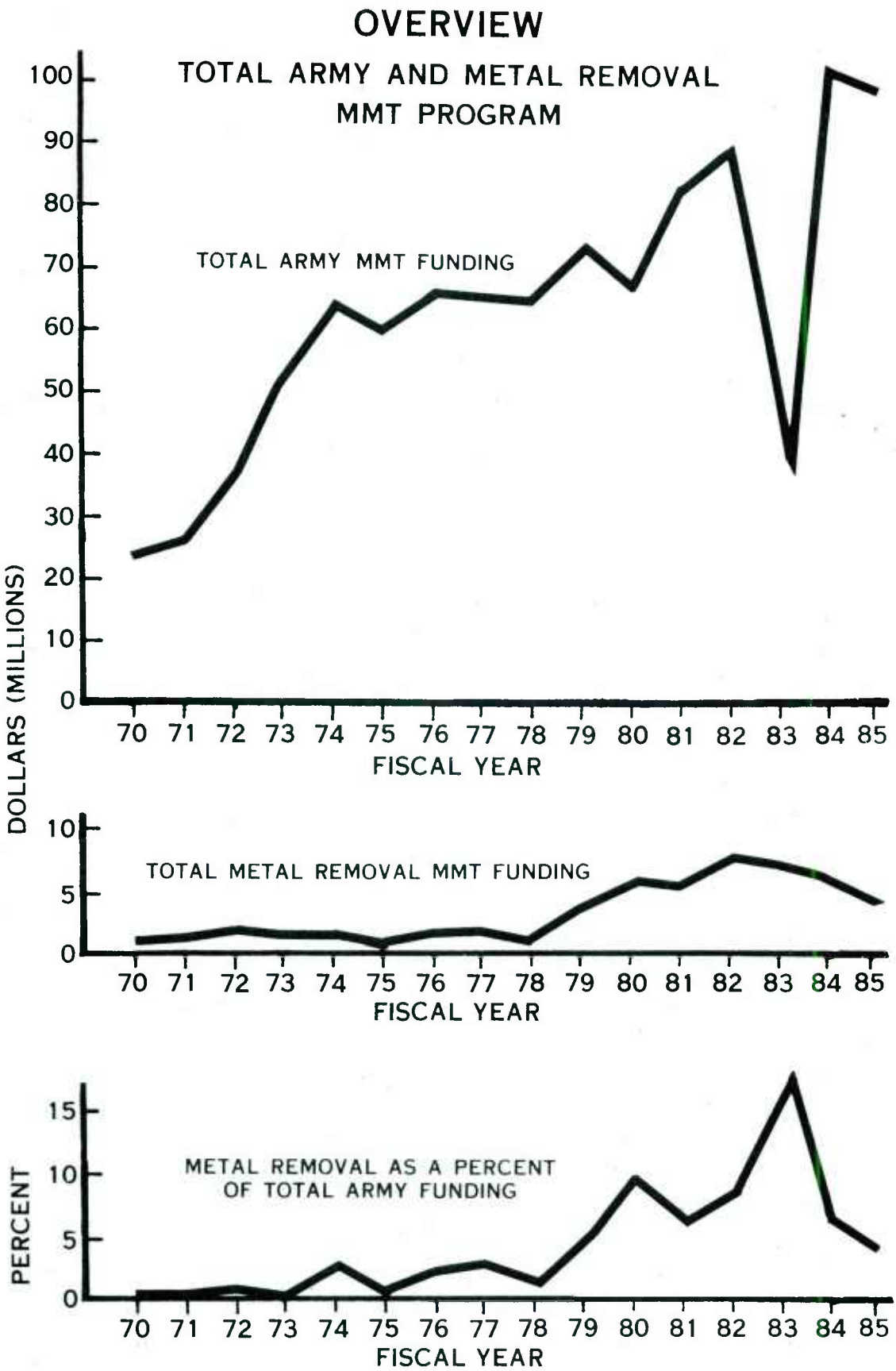


FIGURE 2. OVERVIEW OF TOTAL ARMY AND METAL REMOVAL MMT PROGRAM.

comprises approximately one-sixth of the total active or planned metal removal program.

"Improved Machining Procedures" is the fourth largest metal removal thrust area. It includes projects for the development of data related to machining feeds and speeds, cutting fluids, NC programming languages, tolerances and surface finishes, and machine tool performance specifications. As can be seen from Figure 3, the amount of dollars programmed for this thrust area has been decreasing at a fairly consistent rate.

"Improved Tooling" and "Automation of Machine Support Systems" are the two smallest metal removal thrust areas and together account for only seven percent of the total metal removal program since 1970. While this percentage is low, it should be noted that it has increased by two percentage points since the 1982 MRWG Annual Report and that both categories are trending upward.

METAL REMOVAL THRUST AREAS

| | COMPLETED SINCE FY70 | | ACTIVE | | PLANNED FOR FY84 AND FY85 | | TOTAL METAL REMOVAL PROGRAM | |
|---|---|---|---|---|---|---|---|---|
| | Dollars | Percent | Dollars | Percent | Dollars | Percent | Dollars | Percent |
| Improved Metal Removal Rates | 3376 | 25 | 4269 | 22 | 1955 | 11 | 9600 | 19 |
| Improvment of Current Process Technology | 4931 | 36 | 10262 | 53 | 10113 | 57 | 25306 | 50 |
| Improved Tooling | 479 | 4 | 588 | 3 | 1303 | 7 | 2370 | 5 |
| Computer Integrated Manufacturing Systems | 2156 | 16 | 3109 | 16 | 3167 | 18 | 8432 | 17 |
| Automation of Machining Support Systems | 113 | 1 | 287 | 1 | 848 | 5 | 1248 | 2 |
| Improved Machining Procedures | 2411 | 18 | 1005 | 5 | 419 | 2 | 3835 | 7 |
| TOTAL METAL REMOVAL PROGRAM | 13466 | 27 | 19520 | 38 | 17805 | 35 | 50791 | 100 |

Figure 3 - Funding for Metal Removal Thrust Areas

## RECOMMENDATIONS

In the development of recommendations for future work which should be pursued in the Army's Metal Removal MMT Program, the membership felt that the MMT program should continue to support efforts for the development of machining data in order to identify and document optimum combinations of tool material, tool geometry, and feeds and speeds, with particular attention to O.D. turning, I.D. turning, drilling and milling operations. In this general regard, the membership felt the Army should establish and maintain a strong program for continuing evaluation of new tooling materials and geometries for their potential application to high speed machining.

Recommendations for other technologies which should be supported by the MMT program are listed below:

* Develop a high speed spindle.

* Refine the capability for controlled tap breakage in sequential machining operations.

* Develop and apply in-process inspection systems to control the machine tool.

* Develop the capability to variably control feeds and speeds in order to obtain pre-established metal removal rates.

* Develop and apply an in-process gaging capability.

* Develop and apply a system for acoustic monitoring of tooling condition.

* Investigate single point diamond turning for fire control components manufacturing.

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# APPENDIX A

## MEMBERSHIP ROSTER

## DARCOM METAL REMOVAL WORKING GROUP

## DARCOM METAL REMOVAL WORKING GROUP

| ORGANIZATION | MEMBER | TELEPHONE NUMBER | MT REPRESENTATIVE | TELEPHONE NUMBER |
|---|---|---|---|---|
| AMCCOM<br>DRSMC-IRW-T(R) | Harvey Gabbard | AV 793-5590<br>(309) 794-5590 | Joseph Pohlman | AV 793-3666/3166<br>(309) 3666/3166 |
| AMMRC<br>DRXMR-MPM | Arthur M. Ayvazian | AV 955-5603<br>(617) 923-5603 | John Gassner | AV 955-5521<br>(617) 923-5521 |
| AMMRC<br>DRXMR-MDP | Edwin L. Emerson | AV 955-5459<br>(617) 923-5459 | John Gassner | AV 955-5521<br>(617) 923-5521 |
| ARDC<br>DRSMC-SCM-M(D) | Vincent J. Donadio | AV 880-4615/4512<br>(201) 724-4615/4512 | Donald J. Fischer | AV 880-5957<br>(201) 724-5957 |
| ARDC<br>DRSMC-LCU-M(D) | Richard Meinart | AV 880-6522<br>(201) 724-6522 | Donald J. Fischer | AV 880-5957<br>(201) 724-5957 |
| AVSCOM<br>DRSAV-PEC | Victor Reichert | AV 693-3079<br>(314) 263-3079 | Fred Reed | AV 693-3079<br>(314) 263-3079 |
| BENET WEAPONS LAB<br>DRSMC-LCB-SE | Gary Conlon | AV 974-5737/5590<br>(518) 266-5737/5590 | Donald J. Fischer | AV 880-6092<br>(201) 724-6092 |
| BRDC<br>STRBE-VL | George Farmer, Jr. | AV 354-5374<br>(703) 664-5374 | K. K. Harris | AV 354-5433<br>(703) 664-5433 |

## DARCOM METAL REMOVAL WORKING GROUP

| ORGANIZATION | MEMBER | TELEPHONE NUMBER | MT REPRESENTATIVE | TELEPHONE NUMBER |
|---|---|---|---|---|
| DARCOM<br>DRCMT | Allen Elkins | AV 284-8289<br>(202) 274-8289 | Fred Michel | AV 284-8284/8298<br>(202)274-8284/8298 |
| DESCOM<br>DRSDS-RM-EIE | Jim Shindle | AV 238-6321<br>(717) 263-6321 | Mike Ahearn | AV 238-6591<br>(717) 263-6591 |
| HDL<br>DELHD-IT-RM | Harry E. Hill | AV 290-3124<br>(202) 394-3124 | Julius Hoke | AV 290-1551<br>(202) 394-1551 |
| MICOM<br>DRSMI-RST | Tommy C. Shaw | AV 746-7002<br>(205) 876-7002 | Bobby C. Park | AV 746-2065<br>(205) 876-2065 |
| MPBMA<br>SMCPM-PBM-MC | George P. O'Brien | AV 880-3049/3026<br>(201)328-3049/3027 | Joseph Taglairino | AV 880-6708<br>(201) 724-6708 |
| NRDC<br>DRDNA-EML | Frank Civilikas | AV 256-4883<br>(617) 651-4883 | Frank Civilikas | AV 256-4883<br>(617) 651-4883 |
| RIA<br>SMCRI-ENM-T | Ray Kirschbaum | AV 793-5363<br>(309) 794-5363 | J. W. McGarvey | AV 793-4142/4584<br>(309)794-4142/4584 |
| TACOM<br>DRSTA-RCKM | David J. Pyrce | AV 786-6065<br>(313) 574-6065 | Donald W. Cargo | AV 786-6065<br>(313) 574-6065 |

## DARCOM METAL REMOVAL WORKING GROUP

| ORGANIZATION | MEMBER | TELEPHONE NUMBER | MT REPRESENTATIVE | TELEPHONE NUMBER |
|---|---|---|---|---|
| TECOM<br>DRSTE-AD-M | William H. Deaver | AV 283-2375<br>(301) 278-2375 | John Gehrig | AV 283-3677<br>(301) 278-3677 |
| TROSCOM<br>DRSTR-PT | Richard Green | AV 693-3353<br>(314) 263-3353 | Richard Green | AV 693-3353<br>(314) 263-3353 |
| WVA<br>SMCWV-PPI | Charles Hall | AV 974-4231<br>(518) 266-4231 | William Garber | AV 974-5319<br>(518) 266-5319 |

APPENDIX B

AGENDA

DARCOM METAL REMOVAL WORKING GROUP MEETING

6 - 8 DECEMBER 1983

# 1983 METAL REMOVAL WORKING GROUP MEETING AGENDA

## 6 December

- o Review of Late Start FY84 and FY85 Projects (and Spider Chart Update)
- o Projects Submitted in Support of 1982 Recommendations
- o Projects Completed in 1983
- o 1983 Activities and Accomplishments
- o Recommendations for Future MMT Projects
- o Plans for 1984
- o Annual Report Format
- o Annual Report Distribution
- o MRWG Address Data Base
- O MRWG Membership Roster
- o LLL Machine Tool Tester Proposal

## 7 December

Attend Final Review of DARPA's Advanced Machining Research Program

(All day)

## 8 December

AM - Attend End-Of-Contract Briefing for Air Force MMT Project, "Production Machinability Data and Data Base Program"

PM - Attend Briefing on Kennametal's Standardization Program

# APPENDIX C

## SUMMARY OF DISCUSSIONS

## DARCOM METAL REMOVAL WORKING GROUP MEETING

## 6 - 8 DECEMBER 1983

SUMMARY OF DISCUSSION TOPICS FOR
METAL REMOVAL WORKING GROUP MEETING

1. Seventeen FY84 late start and FY85 new start projects were reviewed by the membership. Highlights of the discussions are as follows:

o Mr. Gary Conlon, Watervliet Arsenal, stated MMT project 6XX 8546, "Machinery Conditions Surveillance System" is a high priority project. Mr. Dave Pyrce, TACOM, was interested in keeping abreast of the status of this project. Mr. Conlon indicated the work will be performed in-house and that Mr. William Sullivan will be the point of contact.

o Mr. Conlon stated MMT project 6XX 8544, "Wire EDM Machining of Rifling Broaches" was in the overprogram status for FY85. Mr. Jim Donadio, ARDC, stated he had attempted to use wire EDM to replace broaching in rifling operations but had experienced difficulty in obtaining sharp corners and was, therefore, thinking of using ECM instead. Mr. Harry Hill, HDL, stated they have done a lot of EDM work through Garret and that they are successfully machining fluidic surfaces with wire EDM.

o Mr. David Pyrce, TACOM, stated MMT project 4XX 4016, "Automated Thermal Cutting of Armor Plate" would probably not be funded. The results of an existing TACOM project, MMT 4XX 6057-04, "Thermal Cutting of Tracked Combat Vehicle Parts" look good. Breadboard equipment has been developed by Southwest Research and Esop-Heath is presently working on prototype equipment.

o Mr. Ray Kirschbaum briefly discussed RIA MMT project 6XX 8702, "Robot Application in Batch Manufacturing" and indicated Mr. John Wilkins was the point of contact. Mr. Tom Shaw, MICOM, stated they are in the process of establishing a Robotics Applications Laboratory. Equipment installation will begin in 1984 and continue into 1985.

o DESCOM MMT project GXX 2004, "Prototype Robot Augmented Computerized Laser Graphics Engraving" was questioned by the membership as being potentially a duplication of WVA MMT project 6XX 8426, "Application of Lasers to Cannon Manufacture."

o Mr. David Pyrce stated TACOM MMT project 4XX 4013, "Improved Machining Processes for TCV Components" will be withdrawn. The work intended for this project will be accomplished by a small rider to existing TACOM MMT project 4XX 5090, "Improved and Cost Effective Machining Technology."

o Mr. Gary Conlon stated WVA MMT project 6XX 8559, "CIM for Cannon CAD/CAM Communication" is their highest priority project for FY85 and that WVA MMT projects 6XX 8550, "Balanced Tool Machining" and 6XX 8542, "Diamond Application to Cannon Manufacture" are very low priority projects.

2. Three MMT projects submitted for FY85 were identified as being in support of recommendations developed at the 1982 Annual MRWG Meeting. They are as follows:

| | |
|---|---|
| 685 8542 | Diamond Application in Cannon Manufacture |
| 685 8550 | Balanced Tool Machining |
| 685 8702 | Robot Application in Batch Manufacturing |

3. Thirteen metal removal related projected completed in FY83 were reviewed by the membership. Several of these projects have produced favorable results and were judged to be good candidates for the agenda of a Metal Removal Conference that may be sponsored by the Metals Subcommittee of MTAG. These projects are as follows:

| | |
|---|---|
| 680 7925 | Bore Evacuator Boring |
| 480 5082 | FMS Pilot Line for TCV Components |
| 481 5090 | Improved and Cost Effective Machining Technology (Phase II) |
| 482 5090 | Improved and Cost Effective Machining Technology (Phase III) |

Members associated with these projects have agreed to solicit papers and presenters in the event these projects are included on the agenda of a future Metal Removal Conference.

4. Discussions related to 1983 MRWG activities and plans for 1984 are summarized on pages 3 and 4 of this Annual Report. Recommendations for future metal removal work are noted on page 11.

5. The last topic discussed was Lawrence Livermore National Laboratory's proposal for a CNC machine tool tester. Both Watervliet Arsenal and TACOM have existing MMT projects in this general area. Mr. Gary Conlon and Mr. David Pyrce indicated the technical direction of their projects are well established. The general consensus of the membership was that a meeting with Lawrence Livermore National Laboratory and others from industry who are working in the general area of machine tool diagnostics was unnecessary.

# APPENDIX D

# SUMMARY OF FINAL REVIEW

# FOR

# ADVANCED MACHINING RESEARCH PROGRAM

SUMMARY OF FINAL REVIEW FOR
ADVANCED MACHINING RESEARCH PROGRAM

Complete documentation for the Advanced Machining Research Program will be available in a multi-volume report which will be distributed in 1984. All attendees at the final review will receive a copy of that report. Highlights of the material presented are as follows:

- Experimental documentation of chip morphology has been achieved.

- It was confirmed that cutting forces decrease as speed increases to a minimum characteristic for a given material.

- Computer modeling of the high speed machining process was accomplished.

- A constitutive equation describing material properties at high stress and strain rates was developed.

- A ledge tool was developed for use in turning, face milling, and end milling.

- A stiffer tooling support system was developed for the rotary tool, and application was demonstrated in difficult to machine materials.

- Continuous wave $CO_2$ laser assisted machining was demonstrated.

- A significant increase in the transfer of power to the workpiece is required in order to approach economic feasibility for $CO_2$ lasers.

- Laser assisted machining using pulsed lasers appears to have promise for Inconel 718 and Ti6AL4V.

- Economic modeling evaluation criteria was established.

- Economic feasibility for high speed machining of aluminum was established.

- Economic limitations for laser assisted machining using continuous wave $CO_2$ lasers were established.

# APPENDIX E

## SUMMARY OF END-OF-CONTRACT DEBRIEFING FOR AIR FORCE MMT PROJECT

## PRODUCTION MACHINABILITY DATA AND DATA BASE PROGRAM

SUMMARY OF END-OF-CONTRACT DEBRIEFING FOR
AIR FORCE MMT PROJECT, "PRODUCTION
MACHINABILITY DATA AND DATA BASE PROGRAM"

The objective of this MMT project was to develop expanded data, analysis techniques, and a computer data base structure for production machinability data. Tasks associated with this project included the following:

- o Develop cutter breakage force limitations for end mills.
- o Develop data for cornering, slotting, and ramping cuts.
- o Design and build a data base structure for end milling.
- o Validate data in a production environment.
- o Develop data for cutting forces, horsepower, and surface finish for Ti6AL4V, 4340 steel, and 7075 aluminum.
- o Redesign and build a data base structure to include other common machining operations.
- o Build a data structure incorporating the ICAM Data Base Management System.

Study variables included workpiece material, end mill cutters, size of cut, and feed rate. Tests were conducted on a No. 5 Cincinnatti milling machine.

The previous approach to machinability data was to store empirical data. Such an approach is limited to existing data and requires experienced personnel. This project developed a dynamic system that has the ability to accept and "learn" from production data.

Features of the system developed are as follows:

- o It is a comprehensive structure that provides for both descriptive and performance related data.
- o It allows for flexible search capability.
- o It allows for the attachment of FORTRAN machining analysis routines.
- o It uses the FORTRAN ICAM Data Base Structure.
- o It is adaptable to various specific environments.
- o It uniquely describes a machining situation.

It is Metcut's opinion that this system provides a basic structure which is capable of incorporating artificial intelligence schemes which will be forthcoming in the future.

Additional information concerning this project may be obtained from Mr. Ed Schopler, Air Force Wright Aeronautical Laboratories, AV 785-2413/3612.

# APPENDIX F

## SUMMARY OF KENNAMETAL'S
## STANDARDIZATION PROGRAM PRESENTATION

# SUMMARY OF KENNAMETAL'S STANDARDIZATION PROGRAM PRESENTATION

During the last ten years, many advances and improvements have been made in the area of cutting tools which have offered the metal removal industry significant methods to increase productivity. While this decade has produced many new tooling products, it has also led to tool confusion and tool misapplication.

As the demand for production increased in the shop, only severe problem areas received adequate attention. Existing tooling has become obsolete and there has been little time to properly evaluate new tooling advances. The result has been loss of tooling capabilities and reduced profit dollars.

Kennametal has developed a solution to the above problem which attempts to achieve maximum tooling capabilities and increase production efficiencies through tool standardization. This tool standardization program is an ongoing tool management program designed to produce more optimum tooling decisions. Benefits of the program are described as follows:

- It sets up an identification system known as ANSI (American National Standards Institute). This identification system is common to all tool suppliers.
- It initiates an update of process sheets and standard rates.
- It maximizes feeds and speeds for the cutting conditions and the horsepower available with each machine tool.
- It reduces the number of brazed tools used and stocked.
- It reduces inventories by grouping similar items.
- It reduces the number of inserts, holders, and cutters stocked.
- It permits volume buying and reduces prices.
- It increases insert life through the elimination of inadequate holders.
- It provides technical in-plant training programs for engineers and operators.
- It reduces the number of special inserts and holders stocked by applying standards and utilizing NC machine capabilities.
- It replaces expensive drills and core drills with the use of drills designed to utilize carbide inserts.

o It increases productivity through proper machine selection and utilization on given product lines.

o It reduces inventories.

o It reduces setup time and tool change time.

o It evaluates and recommends maximum and minimum inventory levels and buying quantities.

o It creates an atmosphere of efficiency.

# APPENDIX G

## METAL REMOVAL

## PROJECT SUMMARIES

# APPENDIX G-1

## COMPLETED PROJECTS

## ABRASIVE METAL REMOVAL PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 6 74 7408 | ABRASIVE MACHINING OF MAJOR COMPONENTS | COMPLETED | 100 |
| 6 77 7408 | ABRASIVE MACHINING OF MAJOR COMPONENTS | UNFUNDED | 365 |
| 6 75 7583 | APPLICATION OF ELECTRO-MECHANICAL MACH TO WEAPON COMPONENTS | COMPLETED | 90 |
| 6 77 7583 | APPLICATION OF ELECTRO-MECHANICAL MACH TO WEAPON COMPONENTS | UNFUNDED | 100 |
| 6 78 7583 | APPLICATION OF ELECTRO-MECHANICAL MACH TO WEAPON COMPONENTS | UNFUNDED | 110 |
| 6 79 7583 | APPL OF ELECT-MECH MACH-EMM-TO WEAPON COMP MFR-20 INCR | UNFUNDED | 115 |

## HIGH SPEED MACHINING PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 3 76 3230 | HIGH SPEED MACHINING OF ALUMINUM | COMPLETED | 242 |
| 5 78 6738 | ULTRA-HIGH SURFACE SPEEDS FOR METAL REMOVAL, ARTY SHELL | UNFUNDED | 472 |
| 5 79 6738 | USE OF ULTRA-HI SURFACE SPEEDS F/METAL REMOVAL, ARTY SHELL | COMPLETED | 181 |
| 5 80 6738 | ULTRA-HIGH SPEED METAL REMOVAL, ARTILLERY SHELL | COMPLETED | 294 |
| 5 81 6738 | ULTRA-HIGH SPEED METAL REMOVAL, ARTILLERY SHELL | UNFUNDED | 57 |

## CHIP EJECTOR TOOLING PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 5 74 6576 | HI-SPEED BORING SUB TASK A-TRIAL SHEAR FORMING OF 155M M483 | COMPLETED | 133 |
| 5 75 6576 | APPLICATION OF HIGH SPEED BORING FOR LG CALIBER SHELL | COMPLETED | 30 |
| 6 77 7652 | COOLANT CHIP EJECTOR, MULTI-OPERATION TOOLING | COMPLETED | 65 |

## AUTOMATED MULTI-SPINDLE/MULTI-TOOLED MACHINING PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 1 76 7103 | IMPROVED MFG-BLISK/ IMPELLER TURBINE ENGINE COMPRESSOR PARTS | COMPLETED | 435 |
| 1 77 7103 | IMPROVED MFG-BLISK/ IMPELLER TURBINE ENGINE COMPRESSOR PARTS | COMPLETED | 305 |
| 6 78 8043 | IMPROVED MACHINING PROCEDURES FOR DOVETAILS | COMPLETED | 100 |
| 6 80 8043 | IMPROVED MACHINING PROCEDURES FOR DOVETAILS | UNFUNDED | 160 |

EFFORT NO. 7408
83/12/09.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 7408 | ABRASIVE MACHINING OF MAJOR COMPONENTS | 74 | 100 | COMPLETED |

PROBLEM AND SOLUTION

PROBLEM - MAJOR CANNON COMPONENTS REQUIRE EXTENSIVE COSTLY MACHINING OPERATIONS. THE CAPABILITY OF ABRASIVE MACHINING TECHNIQUES TO ACHIEVE SIGNIFICANT SAVINGS HAS BEEN DEMONSTRATED IN THE MACHINING OF MINOR COMPONENTS. A SIMILAR RESULT IS SOUGHT FOR MAJOR CANNON COMPONENTS.

SOLUTION - DETERMINE THE CAPABILITY OF THE ABRASIVE MACHINING PROCESS BY EVALUATING PARTS PRODUCED BY IT PRIOR TO THE DESIGN AND PROCUREMENT OF A MACHINE. COMPONENTS WILL BE ROUGH MACHINED, THEN ABRASIVE MACHINED, WITH CAREFUL RECORDS MAINTAINED FOR MATERIAL REMOVED AND MACHINING TIME REQUIRED.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| * 6 7583 | APPLICATION OF ELECTROMECHANICAL MACHINING | 75 | 90 | COMPLETED |

PROBLEM AND SOLUTION

* PROBLEM - MANY RECOIL MECHANISM PARTS REQUIRE CLOSE TOLERANCES AND A VERY FINE SURFACE FINISH WHICH IS DIFFICULT TO PRODUCE A
* ND REQUIRES EXPENSIVE MACHINING METHODS. PRESENTLY, THE PARTS HAVE TO BE GROUND, HONED, LAPPED, AND HAND POLISHED TO OBTAIN T
* HE REQUIRED SURFACE FINISH AND SIZE TOLERANCES, WHICH IS TIME CONSUMING AS THE METAL REMOVAL RATES ARE LOW.

* SOLUTION - ADAPT THE ELECTRO-MECHANICAL MACHINING PROCESS TO EXISTING IN-HOUSE MACHINE TOOLS TO OBTAIN HIGHER MACHINING RATES
* , AND IMPROVED TOLERANCES FOR SIZE, FINISH, AND SURFACE INTEGRITY, THEREBY GETTING AN IMPROVED PRODUCT AT LOWER COST.

EFFORT NO. 3230
83/12/09.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 3230 | HIGH SPEED MACHINING OF ALUMINUM | 76 | 242 | COMPLETED |

PROBLEM AND SOLUTION

PROBLEM - IN MOST ALUMINUM STRUCTURES AND ASSEMBLIES, MACHINING OPERATIONS ARE MAJOR COST ITEMS. RECENT ADVANCES IN MACHINE TOOL DESIGN TECHNOLOGY HAVE DEMONSTRATED SIGNIFICANTLY HIGHER MACHINING RATES. AS AN EXAMPLE, PRELIMINARY TESTS OF MILLING MACHINE OPERATIONS HAVE SHOWN AN INCREASE OF 300 PERCENT IN METAL REMOVAL RATES.

SOLUTION - ANALYZE AND SUMMARIZE ECONOMIC AND PERFORMANCE DATA TO FORM A BASIS FOR GENERAL INDUSTRY-WIDE PROCESS DEFINITION. THIS DATA WOULD INCLUDE CUTTER CONFIGURATION AND SPEED, MACHINE FEED RATE, DEPTH OF CUT, SURFACE FINISH, THREE-AXIS CUTTER LOAD DATA, POWER, AND COOLING REQUIREMENTS. ESTABLISH RELATIONSHIP BETWEEN CUTTING EFFICIENCIES, FORCES, TEMPERATURES AND SPEED FOR VARYING CHIP LOADS, CUTTER CONFIGURATIONS, AND MACHINE OPERATIONS. MAKE AND TEST EXPERIMENTAL TOOLS AS REQUIRED. COMPARE OPTIMIZED MACHINING PERFORMANCE RESULTS WITH NORMAL 'STANDARD' OPERATING SEQUENCES. ANALYZE PRODUCTIVITY IMPROVEMENTS IN TYPICAL PRODUCTION DESIGNS. PREPARE A SET OF GUIDELINES FOR SPECIFYING CUTTER GEOMETRIES, LUBRICANTS, ETC. FOR HIGH SPEED ALUMINUM MACHINING.

EFFORT NO. 0738
83/12/09.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 5 6738 | ULTRA-HIGH SPEED METAL REMOVAL, ARTILLERY SHELL | 79 | 181 | COMPLETED |
| | | 80 | 294 | COMPLETED |

PROBLEM AND SOLUTION

PROBLEM - CONVENTIONAL SPINDLE SPEEDS USED IN THE METAL REMOVAL OPERATIONS FOR 155MM PROJECTILE METAL PARTS VARY FROM 400 TO 500 RPM. REMOVING METAL AT THESE SPEEDS REQUIRES LARGE QUANTITIES OF EQUIPMENT TO ACCOMPLISH A PARTICULAR MACHINING OPERATION . AS AN EXAMPLE, THE 155MM M483 ROUGH TURN OPERATION REQUIRES EIGHT LATHES TO PRODUCE 240 ACCEPTABLE PROJECTILES PER HOUR. TH E APPROXIMATE COST OF A LATHE WITH AUTOMATIC LOAD AND UNLOAD FEATURES, TO PERFORM THIS OPERATION IS $150,000 AND, THEREFORE, A TOTAL COST OF $1,200,000 IS REQUIRED FOR THE EQUIPMENT FOR THIS OPERATION.

SOLUTION - THE SOLUTION TO THIS PROBLEM IS TO INVESTIGATE THE REMOVAL OF METAL AT ULTRA HIGH SPINDLE SPEEDS (5,000-10,000 FPM ). AT SPINDLE SPEEDS TEN TIMES AS HIGH AS CONVENTIONAL SPINDLE SPEEDS, AN INCREASE IN PRODUCTIVITY OF 220 PCT HAS BEEN OBTAIN ED ON ALUMINUM PARTS AND IS HOPED FOR WITH STEEL. SUCH A PRODUCTIVITY INCREASE WILL RESULT A FEWER LATHES REQUIRED AND SIGNIF ICANTLY REDUCE UTILITY COST, DIRECT LABOR COST, AND FLOOR SPACE REQUIREMENTS.

EFFORT NO. 6576
83/12/09.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| * 5 6576 | HIGH SPEED BORING FOR LARGE CAL SHELL | 74 | 133 | COMPLETED |
| * | | 75 | 30 | COMPLETED |

PROBLEM AND SOLUTION

* PROBLEM - THE STANDARD METHOD OF DEEP BORING LARGE CALIBER SHEELS IS BY USING A CONVENTIONAL BORING BAR ARRANGEMENT ON A HOLL
* OW SPINDLE BORING LATHE. ALTHOUGH THE MACHINE HAS THE CAPABILITY OF VERSATILITY IN SPEEDS AND FEEDS, THE COOLANT SYSTEM AND T
* OOLING FLEXIBILITY ARE LIMITED. IN ADDITION, THE ABILITY TO ACHIEVE STRAIGHTNESS OF HOLE, TOOL FAILURE, AND THE PROPER DISPOS
* AL OF THE CHIPS GENERATED DURING THE CUTTING OPERATION ARE AREAS THAT NEED IMMEDIATE ATTENTION.
* SOLUTION - APPLY A HIGH PRESSURE COOLANT BORING SYSTEM TO THE DEEP BORING OF LARGE CALIBER ARTILLERY ITEMS. TOOL MATERIALS, S
* PEEDS, FEEDS, ETC. WILL BE EVALUATED TO REDUCE PROCESS TIME IN BORING WORK MATERIALS. INVESTIGATE HIGH SPEED LOAD/UNLOAD EQUI
* PMENT CONSISTENT WITH THE RAPID BORING PROCESS. DATA WILL BE GENERATED, COMPILED, AND DISSEMINATED FOR CURRENT OR FUTURE USE
IN PROCESSING LARGE CALIBER AMMUNITION.

| | EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|---|
| * 6 | 7652 | APPLICATION OF COOLANT CHIP EJECTOR TOOLING | 77 | 65 | COMPLETED |

PROBLEM AND SOLUTION

* PROBLEM - THE COSTS OF RAW MATERIALS, MULTIPLE-STEP MANUFACTURING OPERATIONS AND SCRAP IN PRODUCING THE CYLINDRICAL COMPONENT S OF RECOIL MECHANISMS ARE INCREASINGLY HIGH. PRESENT USE OF SPECIAL PRECISION-TUBE WORKPIECES IS EXPENSIVE WHILE THE BORING * AND BORE-REAMING TOOLING USED IS ANTIQUATED. MANY OF THE STRESS-RELIEVING AND STRAIGHTENING OPERATIONS, PRESENTLY REQUIRED, C AN BE ELIMINATED.
* SOLUTION - PROCURE, TEST, EVALUATE AND APPLY NEW DRILLING, BORING, BORE-REAMING, TREPANNING, AND INTERNAL CHAMBERING AND SKIV ING MECHANISMS, IN SINGLE AND COMBINED CUTTING OPERATIONS, ON EXISTING IN-HOUSE MACHINE TOOLS. SOME TESTING OF THE NEW LARGE- * BORE MECHANISMS WILL NECESSARILY BE DONE ON NEW, SPECIAL BORING MILLS, UNDER CONTRACT, BEFORE IN-HOUSE ADAPTATION, AND, FOR P REPARATION OF BORING MILL SPECIFICATIONS. ELIMINATE THE BULK OF STRESS-RELIEVING AND STRAIGHTENING OPERATIONS GENERALLY REQUI * RED.

EFFORT NO. 7103
85/12/09.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 1 7103 | BLISK AND IMPELLER MFG BY AUTOMATIC MULTI SPINDLE MACHINING | 76 | 435 | COMPLETED |
| | | 77 | 305 | COMPLETED |

PROBLEM AND SOLUTION

PROBLEM - CURRENT FABRICATION METHODS USED TO PRODUCE PROTOTYPE INTEGRALLY FABRICATED BLISKS FOR THE ADVANCED TURBINE ENGINE COMPRESSOR STAGE INVOLVE SINGLE SPINDLE MACHINING OUT OF A FORGED PANCAKE FOR BOTH THE DISK AND BLADE PORTIONS OF THE BLISK. FINISHING IS PERFORMED BY HAND IN A VERY TIME CONSUMING FASHION.

SOLUTION - DEVELOP MANUFACTURING METHODS AND PROCESSING SPECIFICATIONS FOR THE COST EFFECTIVE PRODUCTION OF INTEGRALLY FABRICATED BLADES AND DISKS (BLISKS) FOR THE T70D ENGINE. NUMERICALLY CONTROLLED, MULTI-SPINDLE MILLING MACHINES WILL BE USED TO MACHINE THE BLISK AND IMPELLER. TOOLING, EQUIPMENT, AND ASSOCIATED MANUFACTURING TECHNOLOGY WILL BE DEVELOPED AND DOCUMENTED IN ORDER TO MEET PRODUCTION SCHEDULES.

| | EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|---|
| * 6 | 8043 | IMPROVE MACHINING PROCEDURES FOR DOVETAILS | 78 | 100 | COMPLETED |

PROBLEM AND SOLUTION

* PROBLEM - RECOIL SLIDE WAYS ARE USED IN THE ASSEMBLY OF LARGE CALIBER WEAPONS. THESE WAYS ARE SECURED TO THE BARREL USING A D
* OVETAIL ASSEMBLY WHICH PROVIDES A MAXIMUM CONTACT AREA AND HIGH STRENGTH. HOWEVER, IN ORDER TO OBTAIN THE MAXIMUM STRENGTH, F
* ULL CONTACT OF THE MATING SURFACES IS REQUIRED. CURRENT PRODUCTION METHODS USE A NUMBER OF MILLING CUTS TO OBTAIN THE FINAL C
* ONFIGURATION WITHIN CLOSE TOLERANCES SPECIFIED. BECAUSE THIS HAS TO BE ACCOMPLISHED IN A SERIES OF PASSES, THERE IS THE POSSI
* BILITY OF MISMATCHING THE ASSEMBLY SURFACES. THE PROBLEM, THEN, IS HOW TO MACHINE DOVETAILS ACCURATELY AND ECONOMICALLY.

* SOLUTION - A METHOD OF BROACHING WILL BE DEVELOPED TO PROVIDE THE COMPLETE DOVETAIL CONFIGURATION ON THE TUBE/HOOP ASSEMBLY.
* SIZE CONTROL WILL BE BUILT INTO THE TOOLING, ELIMINATING THE POSSIBILITY OF OPERATOR ERROR. BROACHING IS A FAR MORE EFFICIENT
* OPERATION THAN MILLING SO IMPROVEMENT WILL BE IN QUANTITY AS WELL AS QUALITY.

## PRECISION MACHINING PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 6 75 7532 | SINGLE POINT CUTTING FOR METAL + PLASTIC OPTICS | COMPLETED | 140 |
| 6 80 8080 | HIGH SPEED FABRICATION OF ASPHERIC OPTICAL SURFACES | UNFUNDED | 204 |
| 6 81 8080 | HIGH SPEED FABRICATION OF ASPHERIC OPTICAL SURFACES | COMPLETED | 20 |
| 6 82 8080 | HIGH SPEED FABRICATION OF ASPHERIC OPTICAL SURFACES | COMPLETED | 20 |

## IMPROVEMENT OF CURRENT PROCESS TECHNOLOGY PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 2 74 9423 | IMPROVED CLOSED CYCLE CRYOGENIC COOLER | COMPLETED | 708 |
| 1 77 7104 | T700 TURBINE ENGINE NOZZLE MANUFACTURING PROCESS | COMPLETED | 36 |
| 1 78 7104 | T700 TURBINE ENGING NOZZLE MANUFACTURING PROCESS | COMPLETED | 32 |
| 5 74 6561 | DEV NEW TECH PIERCING SMALL HOLES IN FUZE-TIMER COMPONENT | COMPLETED | 125 |
| 6 70 6771 | APPL OF IMPVD MACH F/AUTO STEP THREADING BREECH BLOCKS/RINGS | COMPLETED | 122 |
| 6 71 6771 | APPL OF IMPVD MACH F/AUTO STEP THREADING BREECH BLOCKS/RINGS | COMPLETED | 125 |
| 6 74 6771 | DESIGN AND CONSTRUCTREFINED STEP THREAD MACHINE | COMPLETED | 195 |
| 6 73 7246 | BREECH RING MANUFACTURE BY AUTOMATION | COMPLETED | 75 |
| 6 78 7246 | BREECH RING MFG BY AUTOMATION | UNFUNDED | 58 |
| 6 79 7246 | SIMPLIFICATION OF BREECH RING MFG AND HANDLING | CANCELLED | 5 |
| 6 76 7647 | PROCESS FOR MANUFACTURING SWAGING MANDRELS FOR GUN BARRELS | COMPLETED | 100 |
| 6 78 7825 | ELIMINATION OF FACILITATING HONING OPERATIONS | COMPLETED | 133 |

## ADAPTIVE CONTROL PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 6 77 7715 | APPLICATION OF CONTROLLED-FORCE MACHINING | COMPLETED | 64 |

## DUAL RIFLING BROACH REMOVAL PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 6 74 7402 | DEVELOPMENT OF IMPROVED RIFLING PROCEDURES + EQUIPMENT | COMPLETED | 120 |
| 6 75 7402 | DEVELOPMENT OF IMPROVED RIFLING PROCEDURES + EQUIPMENT | CANCELLED | 0 |
| 6 76 7402 | DEVELOPMENT OF IMPROVED RIFLING PROCEDURES + EQUIPMENT | COMPLETED | 46 |

| | EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|---|
| * 6 | 7532 | SINGLE POINT CUTING FOR METAL + PLASTIC OPTICS | 75 | 140 | COMPLETED |

PROBLEM AND SOLUTION

PROBLEM - THE PRESENT METHODS USED TO FORM THE SURFACE OF METAL MIRRORS CAUSES BURNISHING OR CRUSHING OF THE SURFACE AND LEADS TO NON-HOMOGENITY AND CONTAMINATION. SUCH CONDITIONS CANNOT BE TOLERATED IN MIRRORS USED IN HEL SYSTEMS. (HIGH ENERGY LASER)

SOLUTION - AN ENGINEERING SPECIFICATION WILL BE ESTABLISHED BASED ON A COMPOSITE OF EQUIPMENT CAPABILITIES AND REQUIRED SURFACE CHARACTERISTICS OF HEL MIRRORS. EVERY EFFORT WILL BE MADE TO UTILIZE EXISTING INDUSTRIAL DESIGN WHEREVER POSSIBLE. CONTRACTING WILL BE DONE ON A PROPOSAL BASIS AND AFTER FABRICATION AND ACCEPTANCE, THE RESULTANT EQUIPMENT AND METHOD WILL BE ESTABLISHED AT FRANKFORD ARSENAL. SMALL TEST QUANTITIES OF METAL MIRROR SURFACES WILL BE PRODUCED ON THE EQUIPMENT IN-HOUSE TO VERIFY PERFORMANCE AFTER INSTALLATION AND TO ACQUAINT SHOP PERSONNEL WITH THE OPERATION OF THE EQUIPMENT. THE EQUIPMENT WILL THEN BE AVAILABLE FOR GENERAL USE ON THE HELL PROGRAM AND FOR THE SHAPING OF PLASTIC OPTICS AS REQUIRED.

EFFORT NO. 8080
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 8080 | HIGH SPEED FABRICATION OF ASPHERIC OPTICAL SURFACES | 81 | 20 | COMPLETED |
| | | 82 | 100 | COMPLETED |

PROBLEM AND SOLUTION

PROBLEM - OPTICAL COMPONENTS ARE A PERENNIAL REQUIREMENT FOR FIRE CONTROL SYSTEMS AND THE BULK OF THEIR COST LIES IN THE FIXTURING AND POLISHING STAGE. THE COST OF PRODUCTION OF OPTICAL SURFACES CAN BE REDUCED IN TWO WAYS, BY FORMING ACCURATE SURFACES AT THE GENERATION STAGE AND USING THE POLISHING STAGE ONLY TO MAKE THE SURFACE SMOOTHER AND ALSO BY REDUCING THE NUMBER OF ELEMENTS IN OPTICAL SYSTEMS BY USING ASPHERIC SURFACES. ONE METHOD FOR ACCUMPLISHING BOTH REQUIREMENTS IS TO USE THE TUBULAR TOOL GRINDING PROCESS IN A CONFIGURATION IN WHICH THE AXES OF THE WORK AND THE CUP ARE DECENTERED, THUS PRODUCING ASPHERIC SURFACES DIRECTLY DURING THE GRINDING PROCESS. EXPERIMENTAL STUDY HAS BEEN DONE AT THE UNIVERSITY OF ROCHESTER?S INSTITUTE OF OPTICS. ASPHERIC SURFACES HAVE BEEN GENERATED BY THIS PROCEDURE BUT TO BECOME APPLICABLE TO PRODUCTION, FURTHER WORK MUST BE DONE.

SOLUTION - MODIFY THE TUBULAR TOOL GRINDING PROCESS USING A CONFIGURATION IN WHICH THE AXES OF THE WORK AND THE TOOL ARE DECENTERED TO PRUDUCE ASPHERIC SURFACES DURING THE GRINDING OPERATION. THE GROUND SURFACES WILL BE TESTED USING A MOIRE TECHNIQUE. ASPHERIC ELEMENTS (BOTH SIDES) WILL BE GENERATED USING THIS PROCESS RATHER THAN A SINGLE ASPHERIC SURFACE. THE TUBULAR TOOL PROCESS WILL BE INTERFACED TO A LENS DESIGN PROGRAM TO ACHIEVE OPTIMIZATION OF THE USE SINCE NEW OPTICAL FABRICATION METHODS MUST HAVE THEIR RANGES OF APPLICABILITY INCLUDED INTO A LENS DESIGN PROGRAM TO BE USED. A FIRE CONTROL OPTICAL SUBSYSTEM WILL BE FABRICATED ? TESTED USING THIS PROCESS. THIS METHOD REQUIRES NO NUMERICAL CONTROL, ONLY MACHINE SET-UP.

APPROACH

DESCRIPTION OF WORK - FY81 - ASPHERIC GENERATION PROCESS WILL BE MODIFIED AND TESTED OVER A WIDER RANGE OF RADII OF CURVATURE, DIAMETERS AND MATERIALS. ADAPTATION OF MOIRE TECHNIQUES TO MEASURING THE FIGURE OF ROUGE SURFACES. ASPHERIC TWO-SURFACED SINGLE ELEMENTS WILL BE MADE. CANDIDATE FIRE CONTROL OPTICAL SUBSYSTEM WILL BE SELECTED FOR FABRICATION. ASPHERIC GENERATION PROCESS WILL BE INTERFACED TO A LENS DESIGN PROGRAM TO FACILITIATE USE OF PROCESS IN DESIGN PHASE. A TECHNICAL REPORT DETAILING THE RESULTS OF THE FIRST YEAR AND ITS IMPACT ON THE DESIGN PHASE.

FY82 - SELECTED FIRE CONTROL SUBSYSTEM WILL BE FABRICATED USING ASPHERICAL GRINDING METHODS. FABRICATED SUBSYSTEMS WILL BE OPTICALLY TESTED. A TECHNICAL REPORT COVERING THE SECOND YEAR EFFORT WILL BE GENERATED. MILITARY SPECIFICATION FOR THE USE OF THIS PROCEDURE BY INDUSTRY WILL BE WRITTEN.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| H 9423 | IMPROVED CLOSED CYCLE CRYOGENIL COOLER | 74 | 708 | COMPLETED |

PROBLEM AND SOLUTION

PROBLEM - THERE ARE PRESENTLY NO MANUFACTURING TECHNIQUES AVAILABLE FOR THE COOLERS REQUIRED BY THE NIGHT OBSERVATION THERMAL IMAGING DEVICE (AN/TAS-2).

SOLUTION - ESTABLISH THE TIME AND TEMPERATURE CONTROLS FOR HEAT TREATMENT AND SPECIAL FINISHES FOR DISSIMILAR METALS, PRECISE BALANCING OF ALL MOVING PARTS, CONTROL OF DIMENSIONS BY LIGHT SCANNING, ASSEMBLY TECHNIQUES FOR RUBBER AND EPOXY SEALS AND 'O' RINGS, AND SPECIAL TECHNIQUES FOR HERMETICALLY SEALING DISSIMILAR METALS VIA ELECTRON BEAM WELDING. SPECIAL MANUFACTURING TECHNIQUES WILL ALSO BE DEVELOPED FOR MAINTAINING THE VERY CLOSE TOLERANCES WHICH ARE NECESSARY TO CONTROL BALANCING AND HIGH HEAT DISSIPATION.

EFFORT NO. 7104
83/12/09.

| EFFORT NO. | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 1 7104 | TURBINE NOZZLE MANUFACTURING TECHNOLOGY | 77 | 36 | COMPLETED |
| | | 78 | 32 | COMPLETED |

PROBLEM AND SOLUTION

PROBLEM - HISTORICALLY, TURBINE NOZZLES HAVE BEEN HELD (STAGED) IN A MATRIX MATERIAL DURING THE MANUFACTURING PROCESS. THE T7 OD NOZZLES ARE UNIQUE DUE TO THEIR RELATIVELY SMALL SIZE. THIS REDUCES THE HOLDING POWER OF THE MATRIX. IN ADDITION, DIFFICUL TY HAS BEEN ENCOUNTERED WITH THE MATRIX CONTAMINATING OR PLUGGING THE SMALL COOLING HOLES. THERE ARE CONSIDERABLE FORCES INVO LVED DURING THE MACHINING AS THE NOZZLES ARE MADE FROM THE SUPERALLOYS OF COBALT (X-40) AND NICKEL (RENE 80). IN ORDER TO RED UCE THESE FORCES, OPTIMIZATION OF GRINDING TECHNIQUES IS DESIREABLE IN THE FOLLOWING AREAS- INTERNAL CRUSH GRINDING FORM, OD CRUSH GRINDING, AND PRECISE END JOINT GRINDS.

SOLUTION - DEVELOP PROCESSING TECHNIQUES FOR TURBINE ENGINE NOZZLE MANUFACTURING. GRINDING TECHNIQUES WILL BE OPTIMIZED FOR M ACHINING NOZZLES MADE FROM COBALT AND NICKEL ALLOYS. THIS WORK WILL BE PERFORMED MAINLY BY AN INDUSTRIAL CONTRACTOR ENGAGED I N THE DEVELOPMENT OF THE T700 ENGINE. ALL NECESSARY GRINDING TECHNIQUES HAVE BEEN DEVELOPED THROUGH TO COMMERCIAL PRACTISE. I N APPLYING THESE TECHNIQUES TO THE SMALL SIZE NOZZLES USED IN THE T700 ENGINE, IT IS NECESSARY TO SCALE-UP UNCONVENTIONAL HOL DING FIXTURES FOR GRINDING NOZZLE SEGMENTS AS A UNIT AND TO OPTIMIZE THE GRINDING TECHNIQUES FOR THE PARTICULAR COMPONENTS. G RINDING TECHNIQUES WHICH WILL RESULT IN CLOSER DIMENSIONAL CONTROL, IMPROVED ENGINE PERFORMANCE, AND REDUCED HARDWARE REJECT LOSSES ARE THE GOAL OF THIS PROGRAM.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 5 6561 | NEW TECH FOR PIERCING SMALL HOLES IN FUZE-TIMER COMPONENT | 74 | 125 | COMPLETED |

PROBLEM AND SOLUTION

PROBLEM - MILITARY REQUIREMENTS FOR THE MASS PRODUCTION OF ELECTRO-MECHANICAL TIME FUZES DICTATE THAT ALL PARTS BE PRECISE AND INTERCHANGEABLE. THIS ELIMINATES CUSTOM FITTING OF PARTS. THESE COMPONENTS ARE MADE OF VARIOUS MATERIALS AND HAVE SMALL HOLES WITH CLOSE TOLERANCES AND FINE FINISHES. TO DATE THE ONLY KNOWN METHOD OF PRODUCING THESE HOLES IS TO DRILL AND REAM THEM. THIS PRESENTS PROBLEMS IN ATTAINING THE CORRECT DIMENSIONS AND MICRO FINISHES AND REQUIRES HIGHLY SKILLED OPERATORS.

SOLUTION - ESTABLISH A TECHNOLOGY FOR MASS PRODUCTION OF SMALL DEEP PRECISION HOLES VIA A NEW PIERCING TECHNIQUE. ITEMS TO BE INVESTIGATED WILL INCLUDE STUDY OF THE COMPONENT AND THE DESIGN, MANUFACTURE, TEST, AND EVALUATION OF SPECIAL TOOLING REQUIRED, AND THE ESTABLISHMENT OF PROCESS CONTROLS.

EFFORT NO. 6771
83/12/08.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 6771 | DESIGN + CONSTRUCT REFINED STEP THREAD MACHINE | 70 | 122 | COMPLETED |
| | | 71 | 125 | COMPLETED |
| | | 74 | 195 | COMPLETED |

PROBLEM AND SOLUTION

PROBLEM - CURRENT PRACTICE IS TO ROUGH THREAD ON THE FIRST GENERATION STEP THREAD MACHINE, REMOVE AND INSPECT THE BREECH RING , AND THEN FINISH MACHINE ON THE OLD SINGLE POINT PRODUCTION STEP THREADERS. THE PROTOTYPE STEP THREADING REQUIRES THE COMPON ENT TO BE HANDLED THICE BECAUSE OF ITS NON-RETRACTABLE SPINDLE.

SOLUTION - DESIGN AND CONSTRUCT A STEP THREADING MACHINE WITH FEATURES NECESSARY FOR OPTIMUM STEP THREADING. THESE FEATURES I NCLUDE A RETRACTABLE SPINDLE FOR IN-PROCESS GAGING OF THE COMPONENT WITHOUT REMOVAL FROM THE MACHINE AND AN EIGHT STATION IND EXING MECHANISM TO PERMIT USE OF A SINGLE CUTTER BLADE FOR THE FINAL CUT, LEADING TO IMPROVED THREAD LEAD ACCURACY.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 7246 | SIMPLIFICATION OF BREECH RING MFG. AND HANDLING | 73 | 75 | COMPLETED |
| | | 79 | 5 | CANCELLED |

PROBLEM AND SOLUTION

PROBLEM - THE JOB SHOP APPROACH TO MASS PRODUCTION IS AN ANACHRONISM IN TODAYS AGE OF SPECIALIZATION. GENERAL PURPOSE MACHINES ARE RELEGATED TO TOOL ROOMS AND JOB SHOPS WITH THE ADVENT OF HIGH VOLUME PRODUCTION. A UNIT FOR AUTOMATION IS A SPECIAL PURPOSE TOOL DESIGNED TO PERFORM ONE OR MORE REPETITIVE OPERATIONS CONTINUOUSLY. SINCE IT WILL BE USED FOR THAT PURPOSE EXCLUSIVELY, INCLUSION OF UNNECESSARY OR UNRELATED CAPABILITIES NOT ONLY INCREASES THE COST OF THE EQUIPMENT, BUT ALSO INHIBITS THE ABILITY OF THE UNIT TO PERFORM ITS ASSIGNED TASK WITH MAXIMUM EFFICIENCY.

SOLUTION - AN ENGINEERING EFFORT WILL BE DIRECTED TOWARD THE IMPLEMENTATION OF AUTOMATION FOR CANNON BREECH RING MANUFACTURE. AN ANALYSIS AND STUDY OF OPERATIONS WILL BE PERFORMED WITH THE ASSISTANCE OF MACHINE TOOL MANUFACTURERS AND PRODUCTION ENGINEERING PERSONNEL. STANDARD COMMERCIAL ITEMS WILL BE PROCURED OUT-OF-HOUSE WITH ASSEMBLY, INSTALLATION, AND TESTING PERFORMED IN-HOUSE.

EFFORT NO. 7647
83/12/09.

| | EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|---|
| * | 6 7647 | PROCESS FOR MANUFACTURING SWAGING MANDRELS FOR GUN BARRELS | 76 | 100 | COMPLETED |

PROBLEM AND SOLUTION

* PROBLEM - PRESENTLY, NO DOD CAPABILITY EXISTS FOR THE MANUFACTURE OF GUN BARREL SWAGING MANDRELS, AND ONLY ONE PRIVATE COMPAN
Y CAN PRODUCE THE MANDRELS FOR SWAGING CONTEMPORARY GUN-BORE GEOMETRIES.
* SOLUTION - VARIOUS FINE, ACCURATE GRINDING AND FINISHING PROCESSES WILL BE TESTED (WITH RELATED INDEXING, FEEDING, AND IN-PRO
CESS INSPECTION EQUIPMENT) TO PRODUCE THE SWAGING MANDRELS. RELATED EQUIPMENT FOR SHAPING AND DRESSING THE ABRASIVE MECHANISM
* S WILL ALSO BE TESTED AND EVALUATED. THE NECESSARY MACHINE TOOLS, FIXTURES, INSTRUMENTS AND CONTROLS FOR USE OF THE PROCESSES
CHOSEN WILL BE PROCURED AND INSTALLED AT ROCK ISLAND ARSENAL. RIA TOOL MANUFACTURING PERSONNEL WILL BE FAMILIARIZED AND TRAI
* NED FOR USE OF THE PROCESSES AND EQUIPMENT, AND, A TECHNICAL REPORT WILL BE WRITTEN FOR USE BY BOTH IN-HOUSE PERSONNEL AND IN
DUSTRIAL CONTRACTORS.

| EFFORT NO. | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 7825 | ELIMINATION OF FACILITATING HONING OPERATIONS | 78 | 133 | COMPLETED |

PROBLEM AND SOLUTION

PROBLEM - FACILITATING OPERATIONS ARE THOSE WHICH ARE REQUIRED TO ALLOW SUBSEQUENT OPERATIONS TO TAKE PLACE MORE EASILY. IN THE PRODUCTION PROCESS FOR MANUFACTURING GUN TUBES, THERE ARE SEVERAL HONING OPERATIONS WHICH ARE PRESENTLY NECESSARY TO CONSISTENTLY ACHIEVE THE 125 MICRO INCH FINISH NEEDED TO FACILITATE THE SUBSEQUENT SWAGE AUTOFRETTAGE OPERATION. WITH THE ADVENT OF IMPROVED EQUIPMENT FOR BORING TUBES, AS WELL AS IMPROVED TECHNIQUES, THERE IS A REAL POTENTIAL FOR ELIMINATING THE SO-CALLED FACILITATING OPERATIONS.

SOLUTION - BORING LATHES WILL BE SET UP WITH EXPERIMENTAL HEADS, AND FEEDS AND SPEEDS WILL BE VARIED TO IMPROVE AS-BORED FINISHES. PROFILOMETER MEASUREMENTS WILL BE MADE OF EACH VARIED CONDITION TO DETERMINE THE EFFECT OF THE CHANGES ON THE BORE FINISH. IT IS INTENDED TO ADVANCE THE STATE-OF-THE-ART OF BORING TO THE POINT THAT IT WILL PRODUCE FINISHES THAT WILL ELIMINATE THE NEED FOR HONING.

EFFORT NO. 7715
83/12/09.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 7715 | APPLICATION OF CONTROLLED-FORCE MACHINING | 77 | 64 | COMPLETED |

PROBLEM AND SOLUTION

PROBLEM - PRESENTLY THE DETRIMENTAL SPRINGING AND TORQUING OF WORKPIECES AND CUTTING TOOLS THAT COMMONLY OCCUR IN THE INEFFICIENT MACHINING OF RECOIL CYLINDERS, GUN BARRELS, RECEIVERS, ETC., REDUCE MACHINING RATES AND TOOL LIFE, AND PRODUCE SCRAP. THIS INEFFICIENT MACHINING IS COMMON IN TURNING, BORING, MILLING, DRILLING, TAPPING, AND GRINDING OPERATIONS. FOR EXAMPLE, ORDINARY DRILLING OPERATIONS HAVE BEEN PROVEN TO BE 18-38 PERCENT SLOWER THAN DRILLING WITH TORQUE CONTROL.

SOLUTION - PROVIDE THE ENGINEERING DATA AND GUIDELINES REQUIRED TO APPLY CONTROLLED FORCE IN SUPPORTING AND DRIVING WORPIECES AND CUTTING TOOLS, AND TO TAKE ADVANTAGE OF THE RELATED TECHNIQUE OF PRESTRESSING WORKPIECES TO REDUCE CUTTING FORCES AND INCREASE MACHINING RATES. IN-HOUSE WORK WILL APPLY THE PRESTRESSING OF WORKPIECES IN MACHINING. MACHINING WITH CONTROLLED-TORQUE OF THE CUTTING TOOL AND/OR WORKPIECE WILL BE TESTED UNDER CONTRACT.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| * 6 7402 | DEVELOPMENT OF IMPROVED RIFLING PROCEDURES + EQUIPMENT | 74 | 120 | COMPLETED |
| * | | 75 | 0 | CANCELLED |
| * | | 76 | 46 | COMPLETED |

PROBLEM AND SOLUTION

* PROBLEM - THE PRESENT PRACTICE IN RIFLING IS TO DRIVE A SERIES OF DISCS THROUGH THE GUN BARREL IN PROGRESSIVE INCREMENTS. THE POWER REQUIREMENT IS OF RELATIVELY LOW ORDER AND THE STRUCTURE OF THE MACHINE IS CAPABLE OF SEVERAL TIMES THE LOADING APPLIED.

* SOLUTION - MODIFY A SINGLE BAR CONVENTIONAL RIFLER. THE DRIVE SYSTEM WILL BE EQUIPPED WITH DUAL GROOVED BARS AND THE WORK HOLDING FIXTURE WILL BE DESIGNED AND CONSTRUCTED TO SUPPORT TWO BARRELS SIMULTANEOUSLY. A RAPID RETURN STROKE WILL BE DESIGNED AND A BREACH REMOVAL DEVICE WILL ALSO BE INCLUDED IN THE MACHINE MODIFICATION.

## ELECTROCHEMICAL MACHINING PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 6 74 7460 | ELECTROCHEMICAL MACHINING APPLIED TO DEBURRING + SHAPING | COMPLETED | 175 |
| 6 75 7460 | ELECTROCHEMICAL MACHINING APPLIED TO DEBURRING + SHAPING | COMPLETED | 100 |
| 6 77 7485 | APPLICATION OF CHEMICAL PROCESSES TO IMPROVE SURFACE FINISH | COMPLETED | 309 |
| 6 78 7485 | APPLICATION OF CHEMICAL PROCESSES TO IMPROVE SURFACE FINISH | CANCELLED | 0 |
| 6 77 7711 | ELECTROPOLISHING PROCESS MODELS FOR SMALL BORE WEAPONS | COMPLETED | 75 |

## IMPROVED TOOLING PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 5 80 4480 | HIGH SPEED HEAD TURN TOOL MOD F/SC AMMO PROD | COMPLETED | 179 |
| 6 79 7317 | OPTIMIZATION OF STEP THREAD TOOLING | COMPLETED | 75 |

## FLEXIBLE MANUFACTURING SYSTEM PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 5 79 4124 | FABRICATION OF CONTROL ACTUATION SYSTEM HOUSINGS | COMPLETED | 355 |
| 6 79 8104 | IMPROVED BREACH BLOCK MANUFACTURING | COMPLETED | 40 |

## IMPROVED MACHINING PROCEDURES PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 6 76 7203 | APPL OF LEAST COST TOLERANCES AND FINISHES TO PROD OF GUN | COMPLETED | 52 |

## MACHINABILITY DATA PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 1 78 7240 | ESR 4340 MACHINING METHODS FOR HELICOPTER APPLICATIONS | COMPLETED | 117 |
| 1 79 7240 | ESR 4340 MACHINING METHODS FOR HELICOPTER APPLICATIONS | CANCELLED | 7 |
| 1 80 7240 | MACHINING METHODS FOR ESR 4340 STEEL FOR HELICOPTER APPL. | COMPLETED | 94 |
| 6 74 7461 | TOOL AND PROCESS MACHINING FOR SINTERED PM COMPONENTS | COMPLETED | 34 |

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 7460 | ELECTROCHEMICAL MACHINING APPLIED TO DEBURRING + SHAPING | 74 | 175 | COMPLETED |
| | | 75 | 100 | COMPLETED |

PROBLEM AND SOLUTION

PROBLEM - TO PROCURE TOOLING AND EQUIPMENT TO CONVERT MANUFACTURING OF HOWITZER RECOIL CYLINDER COMPONENTS AND SIMILAR WEAPONS COMPONENTS TO FASTER AND MORE ECONOMICAL ELECTROCHEMICAL MACHINING. TO REPLACE VARIOUS MULTIPLE TOOL, STEPPED-MACHINING OPERATIONS OF DRILLING, REAMING, BORING, MILLING AND BROACHING WITH SINGLE, MULTIPLE-TOOL, STRAIGHT AND CAM-GUIDED, PLUNGE-CUTTING OF HOLES, SLOTS, AND CAM SURFACES.

SOLUTION - HOWITZER RECOIL MECHANISM COMPONENT CONFIGURATIONS WILL BE TEST MACHINED, AND THE REQUIRED ELECTRODES, ELECTROLYTES, AND MACHINING PARAMETERS FOR PRODUCTION MACHINING OF THE FULL-SIZED COMPONENTS WILL BE DEVELOPED AND PROVEN. FIXTURING FOR FULL SIZED COMPONENTS AND MULTIPLE-TOOL FEEDING MECHANISM, WILL BE DESIGNED, AND DESIGN OF THE COMPLETE ELECTROCHEMICAL MACHINING SYSTEM WILL BE STARTED. IN THE SECOND YEAR, THE ELECTROCHEMICAL MACHINING EQUIPMENT WILL BE COMPLETED WITH TOOL-FEEDING MECHANISMS AND PARTS FIXTURES. FULL-SIZED COMPONENTS WILL BE RUN IN TESTS, AND THE SYSTEM WILL BE INSTALLED AT ROCK ISLAND.

EFFORT NO. 7485
83/12/12.

| | EFFORT NO. | TITLE | FY | COST | STATUS |
|---|---|---|---|---|---|
| * 6 | 7485 | APPLICATION OF CHEMICAL PROCESSES TO IMPROVE SURFACE FINISH | 77 | 309 | COMPLETED |
| * | | | 78 | 0 | CANCELLED |

PROBLEM AND SOLUTION

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* PROBLEM - DURING THE MANUFACTURE OF GUN TUBES, A CONSIDERABLE NUMBER OF MANHOURS ARE CONSUMED PERFORMING MECHANICAL OPERATION S SUCH AS HONING, GRINDING, DEBURRING, AND BENCHING. AS A RESULT, A SIGNIFICANT OPPORTUNITY FOR COST REDUCTION EXISTS.

* SOLUTION - A MORE EXPEDITIOLS MEANS TO REMOVE METAL AT A CONTROLLED RATE AND WITH NO DANGER OF STRESS DAMAGE TO THE METAL SUR FACE CAN BE ACCOMPLISHED USING SPECIFIC CHEMICAL SOLUTIONS AND ELECTRICAL CURRENT. THIS TECHNIQUE IS CALLED ELECTROPOLISHING.

* LIMITED STUDIES HAVE BEEN PERFORMED WITH ENGINEERING SUPPORT MONEY. THE POTENTIAL FOR FUTURE DEVELOPMENT WAS DEMONSTRATED USI NG SELECTED OPERATIONS SUCH AS BORE SMOOTHING AND DEBURRING.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 7711 | ELECTROPOLISHING PROCESSES FOR ARMAMENT COMPONENTS | 77 | 75 | COMPLETED |

PROBLEM AND SOLUTION

PROBLEM - EVEN THOUGH ELECTROPOLISHING (EP) HAS BEEN USED FOR OVER 30 YEARS IN THE FABRICATION OF MOST SMALL BORE GUN TUBES, STANDARDS OR SPECIFICATIONS HAVE YET TO BE PREPARED. LACKING DETAILED DIRECTIONS FOR THE PROCESS, INDUSTRY AND THE GOVERNMENT ARSENALS PRODUCE UNNECESSARILY HIGH PROPORTIONS OF SCRAP.

SOLUTION - DETERMINE THE EP PROCESS MODEL SO THAT A NEW OPERATOR CAN SET THE OPTIMUM PARAMETERS FOR BATH CHEMISTRY, SURFACE SMOOTHENING LIMITS, BURR REMOVAL, LAND CONTOURING, TAPERING AND PLATABILITY. WITH MODELS FOR THE COMMON MILITARY GUN BARREL STEELS, CONTRACTORS WILL NOT MISTAKENLY ATTEMPT TO APPLY THE SIMILAR ELECTROCHEMICAL MACHINING PROCESS IN AN ATTEMPT TO MEET SMOOTHNESS AND PLATABILITY REQUIREMENTS.

EFFORT NO. 4480
83/12/09.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 5 4480 | HIGH SPEED HEAD TURN TOOL MOD F/SC AMMO PROD | 80 | 179 | COMPLETED |

PROBLEM AND SOLUTION

PROBLEM - SINCE INSTALLATION, THE SCAMP CASE SUBMODULE HAS CONTINUALLY EXPERIENCED AN EXCESSIVELY HIGH USAGE RATE OF HEAD TURN TOOL MODULES. THIS HIGH USAGE RATE IS DUE MORE TO THE TOOL MODULE GOING OUT OF ADJUSTMENT THAN TO BREAKAGE OF THE TOOLING. EFFORTS TO IMPROVE THE CURRENT TOOL MODULE HAVE INCREASED THE TOOL MODULES AVERAGE LIFE TO 20,000 PIECES. HOWEVER, PERFORMANCE IS STILL SPORADIC AND ATTEMPTS AT FURTHER IMPROVEMENT BY MINOR CHANGE HAVE BEEN UNSUCCESSFUL. IN ORDER TO ACHIEVE THE AVERAGE LIFE OF 60,000 PARTS REQUIRED FOR ACCEPTABLE MACHINE DOWN TIME AND REPAIR COST, A MAJOR REDESIGN OF THE TOOL MODULE WILL BE REQUIRED.

SOLUTION - THE PRIMARY PURPOSE OF THIS PROJECT IS TO EVALUATE TWO DESIGNS TO IMPROVE THE HEAD TURN TOOLING. THE FIRST DESIGN EMPLOYS THE USE OF A SELF-OPENING HOLLOW MILL TO REPLACE THE CUTTER AND ROLLER GUIDE ARRANGEMENT CURRENTLY EMPLOYED. SOME PRELIMINARY TESTING HAS INDICATED THAT THIS TYPE OF A DESIGN HAS HIGH POTENTIAL FOR REACHING AN AVERAGE LIFE OF 60,000 PIECES OR BETTER. A SECONDARY EFFORT WILL EVALUATE NEW METHODS OF HOLDING THE PIECE FOR HEAD TURNING. AS PART OF THIS EFFORT THIS PROJECT WOULD ALSO ASSESS THE POSSIBILITY OF KNURLING THE HEAD OF THE CASE (REQUIRED FOR BLANK CARTRIDGE CASES) SIMULTANEOUSLY WITH HEAD TURN.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| * 6 7317 | OPTIMIZATION OF STEP THREAD TOOLING | 79 | 75 | COMPLETED |

PROBLEM AND SOLUTION

* PROBLEM - THERE ARE TWO PROBLEM AREAS. FIRST, BECAUSE OF THE TOOL CONFIGURATION, MUCH OF THE TOOL IS LOST DUE TO LIMITATIONS OF SHARPENING. A TOP RAKE REQUIRES CUTTING DEEP INTO THE CLAMPING THICKNESS DESTROYING CLAMPING SURFACES BEFORE THE TOOL WOUL
* D BE LOST DUE TO REDUCTION OF CUTTER THICKNESS. SECOND, THE MATERIAL SELECTED FOR CUTTER BLADES SHOULD BE EVALUATED IN AN ATT
EMPT TO OBTAIN MORE DURABLE AND MORE READILY GRINDABLE STEEL. ONE CUTTER BLADE COSTS APPROXIMATERLY $550. AN EFFORT TO STRIKE
* A COMPROMISE BETWEEN CUTTER LIFE AND PRODUCTIVITY SHOULD BE SOUGHT.

* SOLUTION - A REDESIGN OF THE CUTTER BLADE AND/OR ITS HOLDER WILL ALLOW A THROUGH PASS OF THE SHARPENING WHEEL PROVIDING MORE RESHARPENING CAPABILITY. NEWER CUTTING STEELS OFFER BETTER FORMABILITY AND CAN PROVIDE FASTER SPEED AND FEED.

EFFORT NO. 4124
83/12/09.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 5 4124 | FABRICATION OF CONTROL ACTUATION SYSTEM HOUSINGS | 79 | 355 | COMPLETED |

PROBLEM AND SOLUTION

PROBLEM - THE HOUSINGS USED IN TACTICAL WEAPONS CONTROL SYSTEMS ARE THE SINGLE MOST HIGH COST ITEM IN THE SYSTEM. ATTEMPTS HAVE BEEN MADE TO PRODUCE THIS ITEM OUT OF NON-METALLIC MATERIALS TO REDUCE COSTS BUT THE LOAD CARRYING REQUIREMENTS DICTATE EXPENSIVE METAL SUPPORTING MEMBERS AND IN MOST CASES ULTIMATELY RESULT IN RESORTING TO STANDARD ALUMINUM HOUSING MADE FROM HIGH COST SINGLE PURPOSE EQUIPMENT OR LOW COST GENERAL EQUIPMENT WHICH RESULTS IN HIGH CYCLE TIME COSTS. THE HIGH VOLUME AUTOMOTIVE TYPE MANUFACTURING CENTERS ARE UNECONOMICAL SOLUTIONS DUE TO QUANTITIES AND EQUIPMENT COSTS.

SOLUTION - THE SOLUTION IS TO DETERMINE A GENERAL METHOD OF FABRICATING ALUMINUM HOUSINGS AT MID VOLUME RATE AND LOW CYCLE COST AND THEN SELECTING A MACHINING CENTER METHOD FOR MULTI MODEL HOUSINGS. THIS WILL BE OF THE CNC AIDED MULTI-MISSION CENTER TYPE DESIGNED TO ECONOMICALLY PRODUCE 12,000 TO 50,000 HOUSINGS PER YEAR.

| | EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|---|
| * 6 | 8104 | IMPROVED BREECH BLOCK MANUFACTURING | 79 | 40 | COMPLETED |

PROBLEM AND SOLUTION

PROBLEM - THE BREECHBLOCK IS A RELATIVELY SMALL COMPONENT. IT IS MANUFACTURED ON STANDARD MACHINE TOOLS SO THAT ONLY A SHORT PORTION OF THE MACHINE IS USED. THE LIFE OF THE MACHINE MAY BE SPENT USING ONLY 10 PERCENT OF THE WAY SURFACES AVAILABLE. THE WIDE VARIETY OF MACHINE TABLE STANDARDS STILL OFFERS EXPENSIVE AND SPACE WASTING ALTERNATIVES TO SPECIFICALLY DESIGNED MANUFACTURING PROCESSES.

SOLUTION - A SPECIFICALLY DESIGN FLEXIBLE MACHINING SYSTEM, USING A PALLETIZED METHOD OF FIXTURING WILL REDUCE MACHINE SPACE REQUIREMENTS AND SIMPLIFY FIXTURING AND TOOLING. IT WILL ALSO MINIMIZE MATERIAL HANDLING, AND BEING A UNIFORM DESIGN, IT WILL ALSO PROVIDE A COMMON INTERFACE OF PALLET TO MACHINE, A FEATURE MOST DIFFICULT WHEN FIXTURING TO GENERAL EQUIPMENT.

EFFORT NO. 7203
83/12/09.

| | EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|---|
| * 6 | 7203 | APPLN OF LEAST COST TOLERANCES AND FINISHES TO PROD OF GUN | 76 | 52 | COMPLETED |

PROBLEM AND SOLUTION

PROBLEM - SURFACE FINISH AND DIMENSIONAL TOLERANCE REQUIREMENTS DICTATE THE MANUFACTURING PROCESS AND MACHINING OPERATIONS WH ICH WILL BE USED TO PRODUCE A COMPONENT. THEY ALSO DIRECTLY AFFECT THE OVERALL PRODUCTION COSTS. THE CLOSER THE TOLERANCE AND THE SURFACE FINISH ARE CONTROLLED, THE MORE EXPENSIVE WILL THE COMPONENT BE TO PRODUCE. WHILE IT IS UNDOUBTEDLY TRUE THAT MO ST REQUIREMENTS ARE NECESSARY, IT IS ALSO TRUE THAT THE COST OF MEETING UNNECESSARILY TIGHT TOLERANCES IS NOT FULLY APPRECIAT ED.

SOLUTION - DETERMINE THE COSTS OF GENERATING DIMENSIONAL TOLERANCES AND SURFACE FINISHES. REVIEW THE OPERATIONAL ROUTING, WHI CH REPRESENTS THE MACHINING REQUIREMENTS FOR EACH OF THE COMPONENTS. FROM THIS REVIEW, CONSIDER THE STEPS IN THE MANUFACTURIN G CYCLE WHICH ARE CONTROLLED BY TOLERANCE AND SURFACE FINISH. CONSIDERATION WILL BE GIVEN TO THOSE INTERMEDIATE TOLERANCES WH ICH ARE NECESSARY TO PRODUCE THE COMPONENT TO THE FINAL DIMENSIONS.

| | EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|---|
| 1 | 7240 | MACHINING METHODS FOR ESR 4340 STEEL | 78 | 117 | COMPLETED |
| | | | 79 | 7 | CANCELLED |
| | | | 80 | 94 | COMPLETED |

PROBLEM AND SOLUTION

PROBLEM - ELECTROSLAG REMELTED (ESR) 4340 STEEL IS CURRENTLY BEING EMPLOYED IN 58 CRITICAL OPERATING PARTS OF THE YAH-64 ARMY HELICOPTER. SINCE THE HIGH QUALITY OF THIS STEEL PERMITS ITS USE AT HIGHER STRENGTH LEVELS THAN CONVENTIONALLY PROCESSED STEELS, THE MACHING TECHNIQUES REQUIRED TO PRODUCE THESE ITEMS HAVE NOT BEEN CLEARLY DEFINED THUS CAUSING CONSIDERABLE MACHINING PROBLEMS WHICH HAVE RESULTED IN COSTLY CONSUMING INEFFICIENT MACHINING PRACTICES. DEVELOPING THE CONVENTIONAL AND UNCONVENTIONAL MACHINING METHODS FOR HIGH STRENGTH ESR STEEL IS NECESSARY TO ALLEVIATE THE EXISTING MACHINING PROBLEMS ASSOCIATED WITH THIS NEW MATERIAL.

SOLUTION - INVESTIGATE MACHINING METHODS TO ESTABLISH THE TECHNIQUES NECESSARY TO FABRICATE ESR STEEL HELICOPTER COMPONENTS. THIS WILL INCLUDE THE DEVELOPMENT OF UNCONVENTIONAL AS WELL AS CONVENTIONAL MACHINING PRACTICES AND PROCEDURES.

EFFORT NO. 7461
83/12/09.

| | EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|---|
| * 6 | 7461 | TOOL AND PROCESS MACHINING FOR SINTERED PM COMPONENTS | 74 | 34 | COMPLETED |

PROBLEM AND SOLUTION

* PROBLEM - MACHINING PROCESS SELECTION GUIDELINES AND MACHINING DATA ARE NOT AVAILABLE FOR POWDERED METAL ALLOYS AND RESULTING HIGH STRENGTH COMPONENTS USED BY THE ARMY.

* SOLUTION - ESTABLISH MACHINING PROCESSES AND PARAMETERS FOR SHAPING, SIZING, AND FINISHING SINTERED POWDERED METAL WEAPONS COMPONENTS OF VARIOUS ALLOYS. THIS INCLUDES BOTH CONVENTIONAL TURNING, MILLING, DRILLING, AND GRINDING, AND UNCONVENTIONAL ELECTRO-CHEMICAL AND ELECTRICAL DISCHARGE PROCESSES REQUIRED FOR VARIOUS ALLOY OF DIFFERENT STRUCTURES, DENSITIES, AND STRENGTHS. MACHINING GUIDELINES FOR PROCESS SELECTION WILL BE DEVELOPED, TO INCLUDE MACHINING PARAMETERS SUCH AS SPEEDS, FEEDS, TOOL MATERIAL, TOOL GEOMETRY, COOLANTS, ETC., IN ORDER TO EFFICIENTLY MANUFACTURE WEAPONS COMPONENTS FROM MOLDED AND SINTERED POWDER METAL BLANKS.

## CUTTING FLUID DATA PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 6 79 7948 | ESTABLISH CUTTING FLUID CONTROL SYSTEM | COMPLETED | 150 |
| 6 80 7948 | ESTABLISH CUTTING FLUID CONTROL SYSTEM | COMPLETED | 158 |
| 6 81 7948 | ESTABLISH CUTTING FLUID CONTROL SYSTEM | COMPLETED | 164 |

## NC LANGUAGE EVALUATION PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| M 75 9000 | IMPROVED PARTS PROGRAMMING NUMERICALLY CONTROLLED MACH | COMPLETED | 8 |
| 2 72 9679 | NUMERICAL CONTROL LANGUAGE EVALUATION | COMPLETED | 225 |
| 2 76 9679 | NUMERICAL CONTROL LATHE LANGUAGE EVALUATION | COMPLETED | 395 |

EFFORT NO. 7948
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 7948 | ESTABLISH CUTTING FLUID CONTROL SYSTEM | 79 | 150 | COMPLETED |
| | | 80 | 158 | COMPLETED |
| | | 81 | 164 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - CUTTING FLUIDS (CF?S) ARE PROCURED ON THE BASIS OF TRIAL-AND-ERROR PROCEDURES. A CF IS PURCHASED AND TRIED FOR A CERTAIN MACHINE OR GROUP OF MACHINES. IF IT SEEMS TO PERFORM SATISFACTORILY, IT IS THEN USED FOR THAT MACHINE GROUPING. THIS IS A NON-QUANTITATIVE EMPIRICAL APPROACH AND OFTEN LEADS TO THE SELECTION OF CF?S WHICH DO NOT GIVE THE LOWEST LIFE CYCLE COSTS. OPTIMUM PROCEDURED FOR MAINTAINING AND REPLACING CF?S ARE OFTEN NOT FOLLOWED BECAUSE THE COST IMPACT IS UNKNOWN.

APPROACH

DESCRIPTION OF WORK - THIS EFFORT COVERS THREE BASIC CF GROUPS - CUTTING OILS, WATER MISCIBLE FLUIDS AND CHEMICAL FLUIDS. DURING FY79, WORK WAS INITIATED TO UPGRADE AND MAINTAIN CUTTING FLUIDS IN BASIC MACHINING OPERATIONS, SUCH AS BROACHING AND DRILLING. THIS WAS BASED ON IMPROVED DESIGN AND CONTROL OF SHOP FLOOR TESTING TO ULTIMATELY PROVIDE METHODS TO CONTROL THE USE OF CUTTING FLUIDS. A LABORATORY SCREENING PROGRAM WAS UNDERTAKEN TO DETERMINE THOSE CUTTING FLUIDS SELECTED FOR SHOP TESTING . THIS ADDRESSED STORAGE ASPECTS OF THE FLUIDS AS WELL AS SERVICE LIFE, CONTROL OF BACTERIA AND FUNGI AND HEALTH PROBLEMS ASSOCIATED WITH THE USE OF CUTTING FLUIDS. A SURVEY ESTABLISHED WHICH FLUIDS WERE BEING USED AND THE MAJOR PROBLEMS. SELECTED MACHINES WERE INSTRUMENTED TO PROVIDE CONTINUOUS EVALUATION OF CUTTING FLUIDS FOR TOOL FORCES, RELATED TOOL WEAR, OIL TEMPERATURE, ETC.

THE FY80 EFFORT WILL COMPLETE THE SET UP OF SHOP FLOOR TESTING AND THE INSTRUMENTED MACHINES FOR CONTINUOUS EVALUATION OF CUTTING FLUIDS. WORK WILL BE INITIATED TO ADDRESS PROBLEMS ASSOCIATED WITH THE USE OF GENERAL CUTTING FLUIDS IN NUMERICALLY-CONTROLLED (NC) MACHINING WHERE WIDELY VARYING REQUIREMENTS FOR TAPPING, MILLING AND BORING MUST BE SATISFIED BY ONE FLUID.

DURING FY81, WORK WILL BE COMPLETED ON THE NC MACHINES. AN OVERALL CONTROL SYSTEM WILL BE ESTABLISHED WITH THE TESTING AND COMPARATIVE PERFORMANCE EVALUATION OF CUTTING FLUID TYPES AND CONCENTRATIONS FOR ALL BASIC MACHINING OPERATIONS. TEST METHODS AND APPLICATION PRACTICES GENERATED WILL BE INTEGRATED INTO THE OVERALL SYSTEM. SOP?S AND PROCESS SPECIFICATIONS WILL BE GENERATED, AS APPLICABLE, TO REFLECT IMPROVED PRACTICES.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| M 9000 | IMPROVED PARTS PROGRAMMING NUMERICALLY CONTROLLED MACH | 75 | 8 | COMPLETED |

PROBLEM AND SOLUTION

PROBLEM - PARTS PROGRAMMING FOR N/C MACHINES IS CONSTAINED BY A LACK OF STANDARDIZATION IN N/C PROGRAM LANGUAGE, DISSIMILARITY OF FUNCTIONS AND TOOLING BETWEEN DIFFERENT MANUFACTURES OF THE SAME EQUIPMENT AND IN MANY INSTANCES BETWEEN SEVERAL UNITS OF THE SAME EQUIPMENT FROM THE SAME MANUFACTURER AND INTERCHANGEABILITY OF N/C TAPES BETWEEN DIFFERENT PRODUCTION UNITS EMBRACING CONTRACTOR AS WELL AS GOVERNMENT INSTALLATIONS. THESE CONSTRAINTS SERIOUSLY LIMIT FLEXIBILITY IN ALTERNATE SOURCES OF MANUFACTURE AS WELL AS REQUIRING REDUNDANT AND DUPLICATE EFFORT TO ACCOMPLISH TASKS WHICH SHOULD BE STANDARDIZED.

SOLUTION - REVIEW N/C PROGRAMMING LANGUAGES TO IDENTIFY THEIR CHARACTERISTICS, ADVANTAGES, AND DISADVANTAGES. REVIEW N/C MACHINERY PERSE WITH A VIEW TOWARD CLASSIFYING THEM BY SIZE, WEIGHT, AXES, MACHINE CONFIGURATION AND MACHINE FUNCTION. STUDY THE PROBLEMS INVOLVED IN THE INTERCHANGEABILITY OF N/C TAPES AMONG PRODUCTION UNITS. REVIEW TOOLS AND TOOL HOLDERS TO ASSESS THE DEGREE OF INTERCHANGEABILITY THAT HAVE COMMON REQUIREMENTS. INCLUDE WITH THIS A REVIEW OF ANY EFFORTS ALONG THIS LINE THAT ARE NOW UNDERWAY BY DOD OR OTHER AGENCIES, NOT EXCLUDING PRIVATE INDUSTRY WHERE SUCH INFORMATION CAN BE OBTAINED.

EFFORT NO. 9679
83/12/09.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 2 9679 | NUMERICAL CONTROL LANGUAGE EVALUATION | 72 | 225 | COMPLETED |
| | | 76 | 395 | COMPLETED |

PROBLEM AND SOLUTION

PROBLEM - THE CONTROL OF ANY AUTOMATIC MACHINE TOOL IS EFFECTED BY THE DATA CONTAINED ON AN OPERATING TAPE. THE GENERATION OF THE CONTROL DATA AND ITS TRANSFER TO THE OPERATING TAPE IS A FUNCTION OF A SOFTWARE PACKAGE REFERRED TO AS A NUMERICAL CONTROL (N/C) LATHE LANGUAGE. THESE N/C LATHE LANGUAGES HAVE IDENTIFYING NAMES AND THERE ARE APPROXIMATELY 17 MAJOR LANGUAGES CURRENTLY IN POPULAR USE. ALL THESE LANGUAGES HAVE FEATURES WHICH MAKE EACH MORE SUITABLE FOR CERTAIN APPLICATIONS THAN OTHERS. THE DEVELOPMENT OF EACH LANGUAGE WAS PERFORMED BY A SPECIFIC GROUP WHICH HAS SINCE BECOME ITS CHIEF ADVOCATE.

SOLUTION - PERFORM AN UNBIASED EVALUATION OF EACH LATHE LANGUAGE, DETAILING ITS ADVANTAGES AND DISADVANTAGES FOR SPECIFIC LATHE OPERATIONS. PARTS PROGRAMS WILL BE DEVELOPED FOR VARIOUS TEST PARTS AND TESTS WILL BE RUN. DOCUMENTATION WILL INCLUDE DRAWINGS OF TEST PARTS, COSTS AND LEAD TIMES FOR PROCESSING AND PROGRAM PREPARATION, TOOLING, DETAILED DESCRIPTIONS FOR THE PURPOSE OF EACH INPUT STATEMENT, CRITERIA USED FOR THE ANALYSIS OF EACH PROGRAM, THE HARDWARE USED, AND THE LEVEL OF TRAINING REQUIRED FOR PERSONNEL WRITING PROGRAMS.

# APPENDIX G-2

# ACTIVE PROJECTS

## IMPROVED METAL REMOVAL RATE PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 6 83 8352 | SKIVING (METAL SHAVING) GUN TUBE BORES | APPROVED | 120 |
| 6 85 8352 | SKIVING (METAL SHAVING) OF GUN TUBE BORES | BUDGET | 575 |

## ABRASIVE METAL REMOVAL PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 181 7376 | AUTO INSPECT AND PRECISION GRINDING OF SB GEARS | APPROVED | 215 |
| 182 7376 | AUTO INSPECT AND PRECISION GRINDING OF SB GEARS | APPROVED | 1012 |
| 183 7376 | AUTO INSPECT AND PRECISION GRINDING OF SB GEARS | CANCELLED | 0 |
| 680 8024 | HIGH SPEED ABRASIVE BELT GRINDING | APPROVED | 324 |
| 682 8024 | HIGH SPEED ABRASIVE BELT GRINDING | APPROVED | 142 |

## HIGH SPEED MACHINING PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 682 7985-C | SMALL ARMS WEAPONS NEW PROCESS TECH-HS MACHINING | APPROVED | 86 |
| 683 7985-C | HIGH SPEED MACHINING | APPROVED | 278 |
| 681 8103 | HIGH VELOCITY MACHINING | UNFUNDED | 68 |
| 682 8103 | HIGH VELOCITY MACHINING | APPROVED | 37 |
| 683 8103 | HIGH VELOCITY MACHINING | APPROVED | 285 |
| 684 8103 | HIGH VELOCITY MACHINING | APPROVED | 160 |
| 680 8106 | LARGE CALIBER POWDER CHAMBER BORING | COMPLETED | 59 |
| 681 8106 | LARGE CALIBER POWDER CHAMBER BORING | APPROVED | 158 |
| 682 8106 | LARGE CALIBER POWDER CHAMBER BORING | APPROVED | 72 |

## CHIP EJECTOR TOOLING PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 682 8238 | BORING BREECH RING LUGS | APPROVED | 203 |

EFFORT NO. 8352
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 8352 | SKIVING OF GUN TUBE BORES | 83 | 120 | APPROVED |
| | | 85 | 575 | BUDGET |

PROBLEM AND SULUTION

PROBLEM - INTERMEDIATE GUN TUBE BORE HONING OEPRATIONS FOR SURFACE FINISH AND SIZE CONTROL CONTINUE TO BE A TIME CONSUMING, C CSTLY METAL REMOVAL PROCESS. COUNTERBORING OPERATIONS PRIOR TO SWAGE AUTOFRETTAGE ARE ALSO SLOW, TIME CONSUMING AND HIGH IN TOOLING COST.

SOLUTION - THE APPLICATION OF RECENTLY DEVELOPED SKIVING TECHNOLOGY AND EQUIPMENT WILL ELIMINATE COSTLY ROUGH HONING AND COUN TERBORING OPERATIONS CONSIDERABLY, PRODUCING ACCEPTABLE BORE TOLERANCES AND SURFACE FINISHES, ELIMINATING ADDITIONAL HONING A ND COUNTERBORING REQUIREMENTS.

APPROACH

DESCRIPTION OF WORK - THE PRIMARY EFFORT FOR THIS PROJECT WILL BE THE APPLICATION OF SKIVING TOOLING AND EQUIPMENT TO MACHINE CANNON TUBE BORES. THE EQUIPMENT PROPOSED WILL BE UNIQUE IN THAT THE CURRENT INTERMEDIATE BORE FINISHING PROCESSES UTILIZE ABRASIVE HONING AND STANDARD COUNTER BORING TECHNIQUES. HOWEVER, THE SKIVING EQUIPMENT WILL PROVIDE ALL THE ADVANTAGES OF DE EP HOLE BORING AND HONING TO PRODUCE THE REQUIRED BORE SIZE AND FINISH AT MUCH GREATER METAL REMOVAL RATES UTILIZING ONLY ONE PIECE OF EQUIPMENT.

TWO AREAS OF APPLICATION HAVE BEEN IDENTIFIED. THESE ARE, ACHIEVING SEMI FINISH BORE SIZE BY SKIVING, ELIMINATING ROUGH HONI NG OPERATIONS AND ELIMINATION OF COUNTER BORING PRIOR TO SWAGE AUTOGRETTAGE. EACH OF THESE HIGH COST OPERATIONS ARE IDEAL CA NDIDATES FOR THE APPLICATION OF SKIVING TECHNOLOGY AND SKIVING EQUIPMENT. IT IS ANTICIPATED THAT THE APPROACH TO THE PROBLEM WILL BE IN THE FOLLOWIG MANNER.

FY83 - ESTABLISH AN IN DEPTH REVIEW AND ENGINEERING ANALYSIS OF THE PROCESS. THIS REVIEW WILL CONTAIN LIMITED TESTING AND RE SULTS OF THAT TESTING. WE WILL REVIEW BOTH DOMESTIC AND FOREIGN SKIVING TECHNOLOGY ALONG WITH SKIVING EQUIPMENT, TOOLING AND APPLICATIONS. AS A RESULT OF THIS COMPREHENSIVE ANALYSIS OF THE PROCESS A COMPLETE ENGINEERING PROCUREMENT SPECIFICATION PA CKAGE OF ALL MAJOR CAPITAL EQUIPMENT AND TOOLING WILL BE PREPARED.

FY85 - PURCHASE, INSTALL, TEST AND IMPLEMENT MAJOR CAPITAL EQUIPMENT, PERIPHERAL SUPPORT HARDWARE AND ALL SPECIALIZED TOOLING TO CONDUCT SKIVING OPERATIONS FOR SIZING OF GUN BORES. IN ADDITION, THE FY85 FUNDING WILL COVER IMPLEMENTATION OF THE EQUIP MENT TO PRODUCTION FACILITIES. SEVENTY-FIVE PERCENT OF THIS YEAR?S FUNDING WILL BE USED FOR EQUIPMENT ACQUISITION WHILE THE REMAINING FUNDING WILL SUPPORT IN-HOUSE ACTIVITIES I.E., ENGINEERING, TESTING, PRODUCTION APPLICATION AND PREPARATION OF THE FINAL TECHNICAL REPORT.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 1 7376 | AUTO INSPECT AND PRECISION GRINDING OF SB GEARS | 81 | 215 | APPROVED |
| | | 82 | 1012 | APPROVED |
| | | 83 | 0 | CANCELLED |

## PROBLEM AND SOLUTION

PROBLEM - THE CURRENT MANUFACTURING METHOD FOR SPIRAL BEVEL GEARS IS LABOR INTENSIVE, REQUIRING CONTACT PATTERN CHECKS WITH EXPENSIVE MASTER MATING GEARS. THIS PATTERN SHIFTS WITH A CHANGE IN TORQUE AND TEMPERATURE. AS A RESULT, THE CURRENT TOOTH FORM EXPERIENCES GREAT STRESS. AN AUTOMATED COORDINATE MEASUREMENT MACHINE WILL PROVIDE PRECISION FINAL INSPECTION BUT CANNOT BE USED FOR IN-PROCESS INSPECTION FOR LACK OF CORRELATION WITH CUTTING/GRINDING MACHINE SETTINGS. SUPERPOSED ADJUSTMENTS IN THE CUTTING/GRINDING MACHINES WILL PROVIDE MORE PROFILE CONTACT THROUGH MORE MATCHING OF RADII OF CURVATURE, BUT THE OPERATIONS ARE MANUAL AND THEREFORE LABOR INTENSIVE.
SOLUTION - DEVELOP AN IN-PROCESS INSPECTION TECHNIQUE WHICH WILL CONVERT READINGS FROM A COORDINATE MEASUREMENT MACHINE INTO PRECISE SETTINGS FOR A GEAR GRINDING MACHINE, THEREBY ALLOWING QUALITY GEAR PRODUCTION OF AN IMPROVED TOOTH FORM WITH ONLY TWO GRINDING PASSES. INDUSTRY R?D HAS PRODUCED A PROTOTYPE IMPROVED TOOTH FORM ON A GRINDER WITH MANUALLY MODIFIED ROLL, TILT, AND GENERATION. THIS IMPROVED TOOTH FORM IS IDENTICAL TO THAT WHICH DEMONSTRATED A 36% IMPROVEMENT IN LOAD CARRYING CAPABILITY ON PARALLEL-AXIS GEARS UNDER NASA-LEWIS CONTRACT.

## APPROACH

DESCRIPTION OF WORK -- ESTABLISH THE MANUFACTURING METHODS AND TECHNOLOGY FOR AUTOMATED INSPECTION AND ONE-TIME AUTOMATIC GRINDING OF IMPROVED-TOOTH FORM SPIRAL BEVEL GEARS IN ARMY HELICOPTER ENGINES AND DRIVE SYSTEMS.
FY 81 - A. USING THE NEW DESIGN GUIDE, SELECT THE GEAR SIZES FOR TOOL TRIAL SPECIMENS OF A TYPICAL SPIRAL BEVEL GEAR AND ITS MATING PINION, FIRST FOR THE CONVENTIONAL TAPERED TOOTH DEPTH AND THEN FOR THE NEW INCREASED TOOTH DEPTHS. B. USING THE NEW EQUATIONS FOR MATCHING MOTIONS, DEFINE THE DRESSER CAMS, GENERATING CAMS, AND CRADLE MOTION CAMS FOR THE SPIRAL BEVEL GEAR GRINDING MACHINE. FABRICATE THE CAMS FOR THE TOOL TRIAL GEARS. C. GENERATE THE SOFTWARE AND FABRICATE THE HOLDING FIXTURE FOR THE GEAR CHECKING MACHINE. D. FABRICATE THE TOOL TRIAL SPECIMENS. COMPARE THE CALCULATED CONTACT PATTERNS WITH THE ACTUALS. E. CONDUCT PARAMETRIC TESTING OF THE TOOL TRIAL SPECIMENS- IDENTIFY THE SENSITIVE PARAMETERS AND MODIFY THE EQUATIONS OF MATCHING MOTIONS. REWORK THE CAMS AS REQUIRED. F. ESTIMATE MANUFACTURING COSTS.
FY 82 - G. FABRICATE SIX SETS OF SPIRAL BEVEL GEARS TO THE STANDARD TOOTH FORM AND 12 SETS TO THE IMPROVED TOOTH FORM. OF THE LATER, SIX SETS WILL HAVE CONVENTIONAL TAPERED TOOTH DEPTH, AND SIX SETS WILL HAVE THE NEW INCREASED TOOTH DEPTH. THESE ARE FULL-SCALE TRANSMISSION GEARS, COLLECTOR MESH. H. PREPARE A MANUFACTURING PROCESS SPECIFICATION (INCLUDING QUALITY ACCEPTANCE CRITERIA). I. UPDATE MANUFACTURING COST ESTIMATES. J. SUBJECT THE GEARS OF TASK G TO PARAMETRIC AND ACCELERATED PROOF TESTING ON A BACK-TO-BACK RIG.
FY 83 K. MODIFY THE DESIGN GUIDE AND THE SOFTWARE FOR THE GEAR GRINDER AND CHECKER AS REQUIRED. L. FABRICATE 3 SETS OF UH60A TRANSMISSION POWER GEARS (21 TOTAL) FOR QUAL TEST. M. 200-HOUR QUALIFICATION TEST ON BACK-TO-BACK UH60A TRANSMISSION TEST RIG.($60K) N. DOCUMENTATION.

EFFORT NO. 8024
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 8024 | HIGH SPEED ABRASIVE BELT GRINDING | 80 | 324 | APPROVED |
| | | 82 | 142 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - THE PROBLEM FOR THE FY80 PROGRAM CITED THE TAPER CAUSED BY TOOL WEAR ON THE SHRINK SURFACES OF THE 8' M201 TUBE. THE FY80 FUNDING SUPPORTED ACQUISITION OF THE MACHINE. IT IS NOW NECESSARY TO APPLY THE TECHNOLOGY TO THE COMPONENT CHOSEN AND DETERMINE THE OPERATING PARAMETERS TO OBTAIN THE MOST ECONOMICAL BALANCE BETWEEN BELT LIFE AND PRODUCTIVITY. BELT GRIT AND GRADE AS WELL AS COOLANT MUST BE REVIEWED. A CONTINUED EFFORT MUST FOLLOW ACQUISITION OF EQUIPMENT THAT OFFERS A NEW TECHNOLOGY BASE. MAXIMUM EFFECTIVEMESS OF THE INVESTMENT CAN ONLY BE REALIZED BY CONTINUING THE PROGRAM TO DETERMINE THE OPTIMUM OPERATING STATISTICS TO THE CITED COMPONENT AND TO SET THE GROUND WORK FOR EXTENDING THIS PROCESS TO OTHER APPLICATIONS.

APPROACH

DESCRIPTION OF WORK - FY80 - PROCURED THE REQUIRED EQUIPMENT. FY82 - ESTABLISH FEED RATE PARAMETERS, DESIGN FIXTURING AND ACCOMPLISH ABRASIVE BELT GRADE. THESE ASPECTS WILL BE EXTENSIVELY TESTED AND FORMULATED INTO THE MOST EFFECTIVE MACHINING PROCESSES AND OPERATING PROCEDURES PRIOR TO TRANSFER TO MANUFACTURING DIVISION. PRODUCTION APPLICATION WILL FOLLOW COMPLETE GENERATION OF THE NEW PROCESS.

| EFFORT NO | SUB TASK | SUBTASK TITLE |
|---|---|---|
| 6 | 7985 C | HIGH SPEED MACHINING |

PROBLEM AND SOLUTION

PROBLEM - CURRENT GUN BARREL MANUFACTURING PROCEDURES REFLECT ANTIQUATED TECHNOLOGY AND RELY ON MASS REMOVAL OF MATERIAL BY CONVENTIONAL MACHINING METHODS. THE COMMON PRACTICE OF GUN DRILLING, RIFLE BROACHING, AND CONTOUR MACHINING OF BAR STOCK NOT ONLY REPRESENTS A TIME CONSUMING METHOD OF OBTAINING THE GEOMETRY REQUIRED, BUT REQUIRES CONSIDERABLE REMOVAL OF COSTLY MATERIAL TO OBTAIN THE FINISHED PRODUCT. MUCH OF THE EQUIPMENT USED TO PERFORM THESE OPERATIONS REPRESENTS 1940-1950 TECHNOLOGY. IN ADDITION, GENERAL CONSENSUS OF INDUSTRY AND GOVERNMENT AGENCIES INDICATE A DIRE NEED FOR UPDATED EQUIPMENT AND NEW PROCESS TECHNOLOGY FOR THE MANUFACTURE OF GUN BARRELS IN THE 20MM TO 40MM SIZE SINCE THE CAPABILITY FOR HIGH PRODUCTION OF THIS RANGE OF BARRELS RESULTS IN A SHORT FALL IN PRODUCTION CAPABILITY REQUIRED TO MEET CURRENT MOB REQUIREMENTS AND PROJECTED PRODUCTION REQUIREMENTS.
SOLUTION - WITHIN THE LAST DECADE, NEW TECHNOLOGY IN THE MANUFACTURE OF GUN BARRELS HAS EMERGED. IN FY80/FY81 THIS PROJECT SUPPORTS THE OPTIMIZATION OF NEW PROCESSES AND THE ESTABLISHMENT OF EQUIPMENT/TOOLING REQUIREMENTS FOR MANUFACTURE OF 5.56MM TO 40MM BARRELS USING THE ROTARY FORGE PROCESS. THE PROJECT ALSO SURVEYED OTHER EXISTING GUN MANUFACTURING OPERATIONS AND PROPOSED ALTERNATE CONCEPTS FOR COST SAVINGS. THIS FY83 PROJECT WILL INVESTIGATE IMPROVED PROCESSES FOR FORMING OF RIFLING IN BARRELS INCLUDING GAIN TWIST BARRELS. BROACH VELOCITY, TOOL CONFIGURATION AND THE LIKE WILL BE OPTIMIZED. ULTRASONIC EXCITATION OF TOOLING WHICH HAS BEEN INVESTIGATED UNDER R?D SUPPORTING PROJECTS WILL BE PUT INTO PRACTICE AND REDUCTIONS IN TIME FOR BROACHING WILL BE DEFINED. THIS PROJECT WILL SUPPORT APPLICATION OF HIGH SPEED MACHINING TECHNOLOGY TO BARREL MANUFACTURE PRIMARILY WITH A SECONDARY EMPHASIS ON OTHER SPECIALIZED SMALL CALIBER COMPONENTS, E.G., BOLTS, AND RECEIVERS WHERE MATERIAL REMOVAL IS STILL A PROBLEM. IT WILL ALSO CONSIDER APPROACHES FOR COMBINING OPERATIONS ON A SINGLE BED FOR REDUCING REQUIRED MATERIAL TRANSFER TIMES.

APPROACH

DESCRIPTION OF WORK - FY82 - MANUFACTURING OF SPECIALIZED WEAPON COMPONENTS, E.G., BOLTS, RECEIVERS, USING HIGH STRENGTH MATERIALS PRESENTLY REQUIRES EXTENSIVE METAL REMOVAL OPERATIONS. MACHINE TIMES TOTAL SEVERAL HUNDRED MINUTES ON A TYPICAL CANNON CALIBER PART WITH A NUMBER OF MANUAL TRANSFER SET-UPS DONE BETWEEN OPERATIONS. PREVIOUS MMT AND EXPLORATORY DEVELOPMENT PROJECTS HAVE SHOWN FEASIBILITY OF APPRECIABLY REDUCING MACHINE TIMES AND INCREASING TOOL LIFE ESPECIALLY ON HIGH STRENGTHS MATERIALS BY THE USE OF HIGH ROTATING SPEEDS FOR CUTTERS, LOCALIZED HEATING BY PLASMA ARC, ULTRASONIC TOOL EXCITATION, AND SLAB AND CONTOUR BROACHING. IT IS PLANNED THIS YEAR TO INVESTIGATE THE APPLICATION OF THESE TECHNIQUES TO THE MANUFACTURE OF A SELECTED GUN BOLT AND RECEIVER, AND DEFINE REQUIREMENTS FOR LUBRICANTS, TOOL LIKE IMPROVEMENTS, MACHINE SPEEDS AND THE LIKES FOR SPECIFIC OPERATIONS UTILIZING A COMBINATION OF ENGINEERING EXTRAPOLATION AND BREADBOARDING.

EFFORT NO. 8103
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 8103 | HIGH VELOCITY MACHINING | 82 | 37 | APPROVED |
| | | 83 | 285 | APPROVED |
| | | 84 | 160 | APPORTIONMENT |

PROBLEM AND SOLUTION

PROBLEM - SPEED OF MACHINING IS DESIRABLE IN DEALING WITH METAL REMOVAL FROM CANNON TUBES WHICH ARE LARGE, LONG (20 TO 30 FT) CYLINDERS HELD TO TIGHT TOLERANCES. CURRENT EQUIPMENT IS LIMITED IN THE SPEED WITH WHICH MATERIAL CAN BE REMOVED.
SOLUTION - METHODS ARE CURRENTLY IN DEVELOPMENT FOR REMOVING METAL AT VERY HIGH RATES OF SPEED. IT IS THE ADAPTATION OF THESE METHODS TO CANNON WHICH OFFER A SOLUTION TO THE NEED FOR HIGH SPEED METAL REMOVAL.

APPROACH

DESCRIPTION OF WORK - CHECK OUT THE APPLICABILITY OF THE AIR FORCE AND MISSILE COMMAND?S PROGRAMS IN HIGH VELOCITY MACHINING WHICH WAS DEVOTED TO ALUMINUM. ALSO, DARPA?S PROGRAM ON HIGH SPEED AND LASER-ASSISTED MACHINING WILL BE MONITORED. AVAILABLE EQUIPMENT WILL BE STUDIED TO DETERMINE IF THE DEVELOPMENTS CAN BE EXTENDED TO STEEL. CONTRACTORS WILL BE CONTACTED TO DETERMINE THE FEASIBILITY OF USING HIGH VELOCITY METHODS ON STEELS. THE FY83 AND FY85 FUNDING WILL SPECIFY AND ACQUIRE EQUIPMENT AND ASSESS THE APPLICATIONS AT WATERVLIET.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 8106 | LARGE CALIBER POWDER CHAMBER BORING | 80 | 59 | COMPLETED |
| | | 81 | 158 | APPROVED |
| | | 82 | 72 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - POWDER CHAMBER CONTOURS ARE CURRENTLY BORED WITH A SINGLE POINT TOOL ATTACHED TO ONE END OF A BAR WHILE THE OTHER END IS SUPPORTED BY THE MACHINE CARRIAGE. CHAMBER DEPTHS ARE OFTEN IN EXCESS OF 3 FEET. TOOL PRESSURE CAUSES DEFLECTION OF THE BAR REDUCING THE ACCURACY OF THE BORING OPERATION AND MAKING IT NECESSARY TO SUBSEQUENTLY SEMIFINISH GRINDING THE CONTOUR. SOLUTION - APPLICATION OF A BALANCE TOOL SYSTEM WILL ELIMINATE THE DEFLECTION PROBLEM THEREBY IMPROVING THE ACCURACY OF THE BORED HOLE MAKING THE ROUGH GRINDING OPERATION UNNECESSARY. AN ADDED BENEFIT IS THAT TWO TOOLS WILL PENETRATE THE WORKPIECE FASTER AND REDUCE BORING OPERATION TIME.

APPROACH

DESCRIPTION OF WORK - GENERATION OF A HYDRAULICALLY POWERED CUTTING TOOL SYSTEM. THE SYSTEM WILL BE UNIQUE IN THAT IN CURRENT CONTOUR BORING SYSTEMS THE CONTOUR IS DEVELOPED BY CROSS MOVEMENT OF THE MACHINE CARRIAGE WHILE IN THE SYSTEM TO BE ESTABLISHED THE BAR MUST BE CENTERED AND THE TOOLS MOVED EQUIALLY BUT INDEPENDENTLY FROM THE BAR TO PRODUCE THE CONTOUR. FY80 - ENGINEERING DESIGN OF TOOLING, POWER CONCEPTS AND PREPARATION OF EQUIPMENT SPECIFICATIONS. FY81 - EQUIPMENT ACQUISITION, INSTALLATION AND INITIAL TESTING. SIXTY-FIVE PERCENT OF THIS YEAR?S FUNDING WILL BE USED FOR EQUIPMENT CONTRACT WHILE THE REMAINING FUNDING WILL SUPPORT IN-HOUSE ENGINEERING AND TESTING COSTS. FY82 - COMPLETE TESTING, ACCOMPLISH PRODUCTION APPLICATION AND PREPARE FINAL REPORT.

EFFORT NO. 8238
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 8238 | IMPROVED BORING TOOLS FOR BREECH RING LUGS | 82 | 203 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - MACHINING LARGE DIAMETER HOLES CONTINUES TO BE A TIME CONSUMING, COSTLY OPERATION. AT PRESENT, TWIST DRILLING, GUN DRILLING, TREPANNING AND FINISH BORING ARE THE METHODS USED TO PRODUCE THE VARIOUS HOLES ON THE BREECH RING LUGS. WHICH METHOD USED IS DETERMINED BY LOCATION, SIZE CONTROL AND FINISH REQUIREMENTS, EACH SOMEWHAT DEPENDENT UPON THE INITIAL CONDITION OF THE MATERIAL TO BE REMOVED.

SOLUTION - A RELATIVELY NEW TECHNOLOGY OF EJECTOR DRILLING AND INDEXABLE CARBIDE INSERT HOLE DRILLING WILL REDUCE THE SEQUENCE STEPS NOW REQUIRED TO PRODUCE AN ACCEPTABLE HOLE. THIS JOINT PROCESS PROVIDES METAL REMOVAL RATES WHICH EXCEED CURRENTLY USED PROCESSES AND CAN BE USED EFFECTIVELY REGARDLESS OF INITIAL STOCK CONDITIONS. CARBIDE INSERT APPLICATION AND THROWAWAY TOOLS ARE FAR MORE COST EFFECTIVE THAN HSS TWIST DRILLS AND GENERALLY THEY PRODUCE A BETTER SURFACE FINISH.

APPROACH

DESCRIPTION OF WORK - THE EXISTING PRODUCTION MACHINES WILL BE UPDATED TO ACCEPT THE NEW HOLE MAKING PROCESS. THIS WILL BE ACCOMPLISHED BY INCREASING THE HORSEPOWER AND SPINDLE SPEEDS WHERE NEEDED, MODIFYING THE COOLANT SYSTEM TO PROVIDE INCREASED PRESSURE, VOLUME AND FILTRATION TO THE NEW CUTTING TOOLS. FIXTURING WILL BE REDESIGNED TO ACCEPT THE NEW CUTTING TOOLS AND TO PROVIDE LOCATION AND SIZE CONTROL TO THE COMPONENT HOLES.

FY82 FUNDING WILL BE USED TO PERFORM AN ANALYSIS OF THE CURRENT MANUFACUTRING OPERATIONS, AND PREPARE SPECIFICATIONS FOR ALL THE EQUIPMENT AND TOOLING NEEDED TO IMPLEMENT THE NEW PROCESS. THE REMAINING FUNDING WILL BE USED TO PROCURE, INSTALL, TEST, EVALUATE AND IMPLEMENT THE PROPOSED SYSTEM.

## PRECISION MACHINING PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| R 79 3445 | PRECISION MACHINING OF OPTICAL COMPONENT | COMPLETED | 300 |
| R 80 3445 | PRECISION MACHINING OF OPTICAL COMPONENTS | COMPLETED | 400 |
| 3 81 3445 | PRECISION MACHINING OF OPTICAL COMPONENTS | APPROVED | 625 |
| 3 82 3445 | PRECISION MACHINING OF OPTICAL COMPONENTS | UNFUNDED | 403 |

## ULTRASONICALLY ASSISTED MACHINING PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 1 76 7156 | ULTRSONICALLY ASSISTED MACHINING FOR SUPERALLOYS. | COMPLETED | 300 |
| 1 80 7156 | ULTRASONIC ASSISTED MACHINING FOR SUPERALLOYS | APPROVED | 60 |

## CREEP FEED CRUSH-FORM GRINDING PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 6 79 8107 | CREEP FEED CRUSH FORM GRINDING | COMPLETED | 82 |
| 6 80 8107 | CREEP FEED CRUSH FORM GRINDING | APPROVED | 579 |
| 6 81 8107 | CREEP FEED CRUSH FORM GRINDING | APPROVED | 73 |

EFFORT NO. 3445
03/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 3 3445 | PRECISION MACHINING OF OPTICAL ELEMENTS | 79 | 300 | COMPLETED |
| | | 80 | 400 | COMPLETED |
| | | 81 | 625 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - WITH INCREASED EMPHASIS WITHIN DOD ON ELECTRO-OPTICAL AND LASER MATERIAL PROGRAMS, THE OPTICAL MANUFACTURING COMMUNITY, WHICH IS BASED PRIMARILY UPON OPTICAL GRINDING AND POLISHING TECHNIQUES, CANNOT KEEP UP WITH THE DEMAND, MEET OPTICAL DESIGN REQUIREMENTS, MEET PRODUCTION SCHEDULES, AND STAY WITHIN REASONABLE COST BOUNDARIES. EXISTING PRECISION MACHINING FACILITIES ARE RESEARCH AND DEVELOPMENT DEVICES AND THERFORE DO NOT LEND THEMSELVES TO PRODUCTION NEEDS.
SOLUTION - TIMELY ADOPTION AND TRANSFER TO INDUSTRIAL OPERATIONS OF PRECISION MACHINING PROCESSES, EQUIPMENT AND PROCEDURES THAT HAVE BEEN DEVELOPED IN R?D LABORATORIES WOULD REDUCE COST, MANUFACTURING TIME, AND PROCUREMENT PROBLEMS ASSOCIATED WITH OPTICAL COMPONENTS. THIS PROGRAM WILL ADOPT AND EXPAND THE TECHNOLOGY DEVELOPED BY ERDA, DOD, AND OPTICAL COMPONENT VENDORS INTO A MANUFACTURING CAPABILITY. EMPHASIS ON THIS PROGRAM WILL BE TO INTEGRATE BOTH THE WELL PROVEN ERDA DEVELOPED SINGLE POINT DIAMOND MACHINING CAPABILITIES AND THE DEVELOPING INTERFEROMETRIC AIDED AND COMPUTER CONTROLLED TECHNOLOGY INTO A MANUFACTURING/PRODUCTION METHOD FOR MIRRORS, LENSES, AND WINDOWS FOR LASER, ELECTRO-OPTICAL, AND MISSILE SYSTEM APPLICATIONS.

APPROACH

DESCRIPTION OF WORK - THE PROGRAM IS PLANNED AS AN ARMY-INDUSTRY CONSORTIUM. THE USA MICOM WILL SERVE AS THE PROGRAM MANAGER DIRECTING THE MACHINE DESIGN AND DEVELOPMENT, THE DOD/ERDA/CONTRACTOR COORDINATION, AND THE DISSEMINATION AND IMPLEMENTATION OF PRECISION MACHINING TECHNOLOGY. THE PRINCIPLE TASK OF THE CONTRACTOR WILL BE TO PARTICIPATE IN DESIGN SELECTION AND FABRICATION OF PRECISION MACHINE HARDWARE, AND CONDUCTING PILOT RUN TESTS. SCHEDULE IS AS FOLLOWS - FY79 - (1) SELECT CONTRACTOR TO IMPLEMENT COMMERCIALIZATION OF DIAMOND TURNING TECHNOLOGY. (2) DETERMINE CURRENT STATE-OF-THE-ART AND DESIGN PRACTICES THROUGH CLOSE COORDINATION WITH ERDA, OTHER DOD AGENCIES AND CONTRACTORS. (3) EVALUATE EXISTING AND PROPOSED CONTRACTOR PRECISION MACHINING FACILITIES AS POTENTIAL SITES FOR TECHNOLOGY TRANSFER TASKS. (4) FABRICATION OF SAMPLES AT EXISTING FACILITIES TO EVALUATE INFLUENCE OF MACHINE DESIGN AND DETAILED SPECIFICATIONS ON QUALITY OF WORK. (5) INITIATE DETAILED DESIGN OF A PRODUCTION PRECISION MACHINE TO INCLUDE INTERFEROMETRIC FEEDBACK AND SURFACE QUALITY CONTROLS.
FY80 - (1) FINALIZE SPECIFICATIONS FOR PRECISION MACHINE PRODUCTION DESIGN INCLUDING MACHINE BED, INTERFEROMETRIC FEEDBACK AND SURFACE QUALITY CONTROLS, COMPUTER AIDED CONTROLS, COOLING TECHNIQUES, TOOL DESIGN, AND MACHINE ERROR BUDGETS. (2) INITIATE PROCUREMENT ACTION FOR MACHINE. (3) INITIATE PRECISION MACHINING OF FLATS AND SPHERES USING GOVERNMENT FURNISHED DIAMOND TURNING.
FY81 - (1) PERFORM MACHINE ACCEPTANCE AND OPERATIONAL TESTS. (2) ESTABLISH PRODUCTION FACILITY REQUIREMENTS. (3) DEMONSTRATE PILOT PRODUCTION CAPABILITY FOR ASPHERIC OPTICAL COMPONENTS. (4) DISSEMINATE TECHNOLOGY. (5) BEGIN INVESTIGATION OF IMPLEMENTING MACHINING OF NEW MATERIALS AND ON-AXIS TURNING OF OFF-AXIS OPTICAL SURFACES.
FY82 - (1) DEMONSTRATE PILOT PRODUCTION CAPABILITY FOR MACHINING NEW MATERIALS. (2) DEMONSTRATE PILOT PRODUCTION CAPABILITY FOR ON-AXIS MACHINING OF OFF-AXIS OPTICAL COMPONENTS. (3) DISSEMINATE TECHNOLOGY.

EFFORT NO. 7156
83/12/09.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 1 7156 | ULTRASONICALLY ASSISTED MACHINING FOR SUPERALLOYS | 76 | 300 | COMPLETED |
| | | 80 | 60 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - IT IS NECESSARY FOR CURRENT HELICOPTER SYSTEMS TO HAVE BALLISTIC RESISTANT COMPONENTS MADE FROM SUPERALLOYS. THESE SUPERALLOYS CANNOT BE MACHINED BY CONVENTIONAL METHODS BECAUSE OF LOW MATERIAL REMOVAL RATES, EXCESSIVE TOOL WEAR, AND POOR SURFACE FINISHES.

SOLUTION - MODIFY AN ULTRASONIC MACHINE TO USE ULTRASONIC ENERGY TO ASSIST IN THE MACHINING OF SUPERALLOYS AND DEVELOP FULL SCALE PRODUCTION CAPABILITY FOR HELICOPTER APPLICATION. SURFACE FINISH WILL BE IMPROVED AND TOOL WEAR, PRODUCTION TIME, AND COSTS WILL BE REDUCED.

PRODUCTION DRAWINGS AND SPECIFICATIONS AND PRODUCTION PROCESS SHEETS. PROTOTYPE ACTUATORS AND CRITICAL TECHNICAL DATA FOR QUALITY ASSURANCE PROVISIONS WILL ALSO BE PROVIDED.

EFFORT NO. 8107
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 8107 | CREEP FEED CRUSH FORM GRINDING | 79 | 82 | COMPLETED |
| | | 80 | 579 | APPROVED |
| | | 81 | 73 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - DESPITE RECENT ADAPTION OF NC MACHINING CENTERS, THE COST OF PRODUCING CERTAIN INTRICATE STRAIGHT FORMS ON COMPONENTS REMAINS A BOTTLENECK OPERATION. THE AVAILABILITY OF THESE MACHINING CENTERS IS LIMITED AND MOST ARE WORKING AT NEAR MAXIMUM CAPACITY. CONVENTIONAL GRINDING OPERATIONS HAVE A DIFFERENT LIMITATION IN THEIR METAL REMOVAL CAPACITY WHEN APPLIED TO INTRICATE CONFIGURATION DEVELOPMENT.

SOLUTION - THE FY79 PROJECT DEMONSTRATED THE ADAPTABILITY OF CREEP FEED GRINDING. A MACHINE SPECIFICATION WAS PREPARED. THE FY80 FUNDS WILL REQUIRE THE PROTOTYPE EQUIPMENT. FY81 FUNDING WILL BE USED FOR FINAL TESTING, PRODUCTION APPLICATIONS WHICH WILL INCLUDE TOOLING FOR A SECOND COMPONENT, AND FOR PREPARATION OF THE FINAL REPORT AND DECUMENTS REQUIRED FOR THE TRANSFER OF EQUIPMENT FROM EXPERIMENTAL TO PRODUCTION FACILITY.

APPROACH

DESCRIPTION OF WORK - TWO AREAS OF APPLICATION HAVE BEEN VERIFIED AS CANDIDATES FOR CREEP FEED CRUSH FORM GRINDING. THESE ARE THE BRACKET SLOT ON THE 105MM M68 BREECH BLOCK AND THE RACK TEETH ON THE 152MM M162 COUPLING. IN FY79, A SPECIFICATION FOR A CREEP GRINDER WAS PREPARED. TO AID IN THE PROVE-OUT, THE TOOLING PACKAGE WILL ALSO BE SPECIFIED. THE SCOPE OF WORK TO BE PERFORMED WITH THE FY80 FUNDING IS TO BUY THE EQUIPMENT SPECIFIED. THE FUNDING ALSO SUPPORTS INSTALLATION AND INITIAL TESTING OF THE EQUIPMENT. FY81 FUNDING WILL BE USED FOR FINAL TESTING, PRODUCTION APPLICATIONS TO INCLUDE TOOLING FOR A SECOND COMPONENT, AND FOR PREPARATION OF THE FINAL REPORT AND DOCUMENTS REQUIRED FOR THE TRANSFER OF EQUIPMENT FROM EXPERIMENTAL TO PRODUCTION FACILITY. APPROXIMATELY 88% OF FY81 FUNDING WILL BE SPENT IN-HOUSE AND 12% OUT-OF-HOUSE.

## IMPROVEMENT OF CURRENT PROCESS TECHNOLOGY PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 1 81 7366 | SPIRAL SELF-ACTING SEAL | CANCELLED | 0 |
| 1 82 7366 | SPIRAL SELF-ACTING SEALS | APPROVED | 370 |
| 1 84 7366 | SPIRAL SELF-ACTING SEALS | APPORTIONMENT | 700 |
| 1 85 7366 | SPIRAL SELF-ACTING SEALS | BUDGET | 300 |
| E 77 3749 | HYDRAULIC ROTORY ACTUATORS | APPROVED | 750 |
| E 80 3749 | HYDRAULIC ROTARY ACTUATORS | APPROVED | 145 |
| E 81 3749 | HYDRAULIC ROTARY ACTUATORS FOR M9 | APPROVED | 106 |
| 5 79 4189 | HIGH FRAGMENTATION STEEL PRODUCTION PROCESS | COMPLETED | 747 |
| 5 80 4189 | HIGH FRAGMENTATION STEEL PRODUCTION PROCESS | APPROVED | 1048 |
| 5 81 4189 | HIGH FRAGMENTATION STEEL PRODUCTION PROCESS | CANCELLED | 0 |
| 5 82 4189 | HIGH FRAGMENTATION STEEL PRODUCTION PROCESS | COMPLETED | 110 |
| 5 82 4563-05 | REDUCTION OF CHIPS OXIDATION | APPROVED | 169 |
| 5 83 4563-05 | REDUCTION OF CHIP OXIDATION | APPROVED | 188 |
| 6 77 7482 | MODIFIED RIBBON RIFLING GENERATING MCH | UNFUNDED | 112 |
| 6 79 7482 | MODIFIED RIBBON RIFLING GENERATING MACHINE | APPROVED | 76 |
| 6 77 7730 | NEW MFG TECHNIQUES APPLIED TO PRODUCT. OF SPLIT RINGS | UNFUNDED | 72 |
| 6 78 7730 | MFG OF SPLIT RING BREECH SEALS | UNFUNDED | 133 |
| 6 79 7730 | MANUFACTURE OF SPLIT RING BREECH SEALS | COMPLETED | 137 |
| 6 80 7730 | MANUFACTURE OF SPLIT RING BREECH SEALS | APPROVED | 363 |
| 6 82 7730 | MANUFACTURE OF SPLIT RING BREECH SEALS | APPROVED | 108 |
| 6 79 7925 | BORE EVACUATOR BORING | UNFUNDED | 93 |
| 6 80 7925 | BORE EVACUATOR BORING | COMPLETED | 111 |
| 6 81 7925 | BORE EVACUATOR BORING | APPROVED | 248 |
| 6 80 7927 | GENERATION OF BASE MACHINING SURFACES | COMPLETED | 35 |
| 6 81 7927 | GENERATION OF BASE MACHINING SURFACES | APPROVED | 422 |
| 6 82 7985-B | SMALL ARMS WEAPONS NEW PROCESS TECH-BARREL BROACHING | APPROVED | 200 |
| 6 83 7985-B | BARREL BROACHING | APPROVED | 171 |
| 6 78 8047 | PASS THRU STEADY RESTS FOR TUBE TURNING | COMPLETED | 139 |
| 6 80 8047 | PASS THRU STEADY RESTS FOR TUBE TURNING | APPROVED | 369 |
| 6 80 8105 | ESTABLISH ROUGH THREAD BLANKS, 8-INCH M201 BUSHING | COMPLETED | 88 |
| 6 81 8105 | ESTABLISH ROUGH THREAD BLANKS, 8 IN M201 BUSHING | APPROVED | 292 |
| 6 81 8246 | IMPROVED GAS CHECK SEAT FINISHING | COMPLETED | 60 |
| 6 82 8246 | GAS CHECK SEAT FINISHING | APPROVED | 153 |
| 6 82 8250 | IMPROVED FABRICATION OF RECOIL WEAR SURFACES | CANCELLED | 0 |
| 6 83 8250 | IMPROVED FABRICATION OF RECOIL WEAR SURFACES | UNFUNDED | 125 |
| 6 84 8250 | IMPROVED FABRICATION OF RECOIL WEAR SURFACES | APPROVED | 28 |
| 6 85 8250 | IMPROVED FABRICATION OF RECOIL WEAR SURFACES | BUDGET | 269 |
| 6 80 8341 | HOLLOW CYLINDER CUT OFF MACHINE | CANCELLED | 0 |
| 6 81 8341 | HOLLOW CYLINDER CUT OFF MACHINE | COMPLETED | 84 |
| 6 82 8341 | HOLLOW CYLINDER CUT OFF MACHINE | APPROVED | 655 |
| 6 83 8351 | IMP MANUFACTURE OF QUADRANT FLATS AND MUZZLE BRAKE KEYWAY | APPROVED | 88 |
| 6 85 8351 | IMP MFG OF QUADRANT FLATS AND BRAKE KEYWAY | BUDGET | 350 |
| E 78 3717 | HIGH TEMPERATURE TURBINE NOZZLE FOR 10 KW POWER UNIT | COMPLETED | 339 |
| E 79 3717 | HIGH TEMPERATURE TURBINE NOZZLE FOR 10KW POWER UNIT | UNFUNDED | 343 |
| E 80 3717 | HIGH TEMPERATURE TURBINE NOZZLE FOR 10 KW POWER UNIT | COMPLETED | 436 |
| E 81 3717 | HIGH TEMPERATURE TURBINE NOZZLE FOR 10 KW POWER UNIT | APPROVED | 422 |

EFFORT NO. 7366
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 1 7366 | SPIRAL SELF-ACTING SEAL | 81 | 0 | CANCELLED |
| | | 82 | 370 | APPROVED |
| | | 84 | 700 | APPORTIONMENT |
| | | 85 | 300 | BUDGET |

PROBLEM AND SOLUTION

PROBLEM - THERE IS A NEED FOR A ZERO-LEAKAGE AIR-TO-AIR SEAL WHICH CAN WITHSTAND WITHOUT DEGRADATION THE HIGH TEMPERATURES/PRESSURES AND HIGH RUBBING VELOCITIES IN THE ARMYS CURRENT MAN-RATED ENGINES. LABYRINTH SEALS IN CURRENT THRUST-BALANCE-PISTON APPICATIONS HAVE DEFINITE LEAKAGE RATES WHEN NEW, WHICH PROGRESSIVELY WORSEN WITH SEAL WEAR, RESULTING IN SIGNIFICANT POWER LOSS AND EVENTUALLY PREMATURE REPLACEMENT. TO COMPENSATE FOR THIS POWER LOSS, THE ENGINE MUST OPERATE AT HIGHER SPEEDS AND TEMPERATURES WHICH TRANSLATE TO INCREASED FUEL CONSUMPTION AND DECREASED ENGINE LIFE. SELF-ACTING SEALS WILL SOLVE THESE FIELD PROBLEMS BUT ARE LABOR INTENSIVE, REQUIRING HAND GRINDING OF THE SPIRAL GROOVES IN THE STEEL FACE.

APPROACH

DESCRIPTION OF WORK - THIS PROJECT WILL ESTABLISH THE MANUFACTURING METHODS AND TECHNOLOGY FOR SPIRAL-GROOVE SELF-ACTING SEALS FOR USE IN ARMY GAS TURBINE ENGINES, AS APPLIED TO THE INNER BALANCE PISTON AS FOLLOWS - FY82 - USING THE NEW DESIGN GUIDE, SIZE THE SPIRAL-GROOVE SELF-ACTING SEAL FOR THE T700 INNER-BALANCE-PISTON APPLICATION, DEVELOP THE MANUFACTURING PROCESS, ESTABLISHING PARAMETERS FOR AUTOMATED SPIRAL GROOVING OF THE STEEL SEAL FACE IN GANGS, ESTIMATE MANUFACTURING COSTS. FY83 - PILOT PRODUCTION OF SIX T700 ENGINE SETS OF IBP SEALS, ESTABLISH QUALITY ACCEPTANCE CRITERIA, PREPARE MFG PROCESS SPEC., INCLUDING QUALITY ACCEPTANCE CRITERIA, VALIDATION (RIG) TESTING OF THE FABRICATION BY GANG GROOVING TECHNIQUE,UPDATE MFG COST ESTIMATE. FY84 - PIGGY-BACK ENGINE AND FLIGHT TESTS, CIP AND FT. RUCKER, PROVIDE TECHNICAL SUPPORT TO PIGGY-BACK ENGINE AND FLIGHT TESTING, FAILURE ANALYSIS AS REQUIRED, GOVERNMENT/INDUSTRY BRIEFING, DOCUMENTATION.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 4 3749 | HYDRAULIC ROTOR ACTUATORS | 77 | 750 | APPROVED |
| | | 80 | 145 | APPROVED |
| | | 81 | 106 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - ROTARY ACTUATORS ARE CRITICAL COMPONENTS OF THE M9 HYDROPNEUMATIC SUSPENSION SYSTEM, THE MOST COSTLY VEHICLE ELEMENT. TO REDUCE COST AND MEET THE REQUIRED SCHEDULE, A MANUFACTURING PROCESS FOR MASS PRUDUCTION MUST BE DEVELOPED. ACTUATORS FABRICATED UNDER THIS MM?T HAVE BEEN EXTREMELY COSTLY DUE TO HIGH SCRAP RATES ON THE CORNER PORTED END COVERS. TO RESOLVE THIS PROBLEM, A DIFFERENT CASTING AND MACHINING APPROACH, WHICH WILL SIMPLIFY THE PRESENT CASTING AND MACHINING PROCESS, HAS BEEN APPROVED. IN ADDITION, IT IS APPARENT THAT A PRODUCTION ACTUATOR BENCH TEST PROCEDURE AND EQUIPMENT MUST BE DEVELOPED TO ASSURE RELIABILITY AND DURABILITY OF THESE CRITICAL AND EXPENSIVE VEHICLE COMPONENTS.
SOLUTION - THIS PROJECT WILL DEVELOP THE PRODUCTION PROCESSES (METHODS, PROCEDURES, MACHINERY AND TOOLING) NEEDED TO PRODUCE HIGH QUALITY PRECISION TYPE ACTUATORS ON PRODUCTION MACHINERY.

APPROACH

DESCRIPTION OF WORK - TO DATE, TEN ACTUATORS (4 CORNER, 6 INTERMEDIATE) HAVE BEEN MANUFACTURED AND BENCH TESTED, AND EIGHT UNITS HAVE BEEN SUCCESSFULLY TESTED ON A VEHICLE FOR APPROXIMATELY 150 HOURS. ONLY FOUR CORNER UNITS COULD BE ASSEMBLED (6 REQUIRED) DUE TO THE HIGH SCRAPPAGE RATE RESULTING FROM THE CORNER PORTED END CASTING/MACHINING PROCEDURES. THIS REVISION TO THE MM?T IS NECESSARY TO PERMIT FABRICATION OF THE TWO REMAINING CORNER UNITS BY REVISED METHODS, TESTING AND EVALUATING THE UNITS, REVISING THE ACTUATER TECHNICAL DATA TO INCLUDE THE NEW PROCEDURES IF ACCEPTABLE, AND DEVELOPING THE NECESSARY PRODUCTION ACTUATOR TEST REQUIREMENTS. THESE REQUIREMENTS FOR FUTURE PRODUCTION BENCH TESTS ARE VITAL TO REDUCE ANY POTENTIAL RISK THAT PRODUCTION ACTUATOR RELIABILITY OR DURABILITY MIGHT NOT BE ACCEPTABLE IN THE FIELD.

EFFORT NO. 4189
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 5 4189 | HIGH FRAGMENTATION STEEL PRODUCTION PROCESS | 79 | 747 | COMPLETED |
| | | 8D | 1D48 | APPROVED |
| | | 81 | D | CANCELLED |
| | | 82 | 11D | COMPLETED |

PROBLEM AND SOLUTION

PROBLEM - LIMITED UNECONOMICAL PRODUCTION OF HIGH FRAGMENTATION STEEL PROJECTILE METAL PARTS HAS EXPOSED MANY PROBLEMS AND TH E NEED FOR INVESTIGATION INTO AND REFINEMENT OF PRODUCTION PROCESSES AND TECHNIQUES WHICH WILL REDUCE UNIT COSTS, WHILE YIELD ING THE QUALITY PRODUCTS REQUIRED. PROBLEMS INCLUDE OVERSIZE MULTS DUE TO FORGING ECCENTRICITY, HIGH ENERGY REQUIREMENT OF T HE SPHEROIDIZE ANNEAL OF FORGINGS, 2-HIT NOSING OPERATION REQUIRING AN INTERMEDIATE STRESS RELIEF, INABILITY OF HEAT TREATME NTS TO IMPART BOTH MECHANICAL PROPERTIES AND THE TOUGHNESS REQUIRED FOR DROP TESTING, LACK OF AN ECONOMICAL TECHNIQUE FOR TES TING THAT TOUGHNESS AND AN EXTREMELY HIGH REJECT RATE. ALSO, HIGH FRAGMENTATION STEEL ANOMALIES SUCH AS HEAT-TO-HEAT CHEMIST RY, ALLOY SEGREGATION, AND MATERIAL SOUNDNESS NEED TO HAVE THEIR IMPACT ASSESSED AND INSPECTABILITY DETERMINED.
SOLUTION - NEW AND IMPROVED PRODUCTION PROCESSES AND TECHNIQUES WILL BE EXAMINED AND REFINED RELATIVE TO THE MANUFACTURE OF H IGH FRAGMENTATION STEEL PROJECTILE MATAL PARTS. GENERAL AREAS OF STUDY WILL INCLUDE REDUCTION OF STARTING MULT WEIGHT VIA FO RGE TOOLING DESIGNS, OPTIMIZATION OF MACHINING TECHNIQUES, DETERMINATION OF NECESSITY TO SPHEROIDIZE ANNEAL FORGINGS, REFINEM ENT OF HOT NOSING PROCESS WITH FOLLOWING INDUCTION STRESS RELIEF OF NOSED BODIES, EXAMINATION OF VARIOUS HEAT TREATMENTS, AND DETERMINATION ON NEW FRACTURE TOUGHNESS TEST. ALL PROJECTILE METAL PARTS WILL BE PROCESSED TO END ITEM SPECIFICATION AND DR AWINGS IN ORDER TO EVALUATE WHERE POSSIBLE. THE 155MM M549 WILL BE TEST VEHICLE FOR THIS WORK.

APPROACH

DESCRIPTION OF WORK - (FY79) - CONTRACTOR HAS PURCHASED TWO HEATS OF HF-1 STEEL MANUFACTURED BY BOF PROCESS. THIS HAS BEEN T HOROUGHLY CHARACTERIZED METALLURGICALLY. HARRY DIAMOND LABS (HDL) INVESTIGATED FLUIDICS AS A METHOD OF MORE ACCURATELY MEASU RING MULT TEMPERATURE.
(FY80) - THE SELECTED CONTRACTOR UTILIZED THE TWO HEATS OF HIGH FRAGMENTATION STEEL. THE 155MM M549 WAS SELECTED AS TEST VEH ICLE. MULT PARTING TECHNIQUES WERE EVALUATED. FORGE TOOLING WAS DEVELOPED WHICH WILL YIELD A BODY AS NEAR TO NET DIMENSIONS AS POSSIBLE. GOAL OF THIS WORK WAS TO MINIMIZE STARTING MULT WEIGHT AND MACHINING TIME. NECESSITY OF SPHEROIDIZE ANNEAL OF FORGING WAS INVESTIGATED. REPERCUSSIONS ON MACHINING AND OTHER SUBSEQUENT PROCESSING WAS DETERMINED. HDL DETERMINED THE MA TERIALS TO BE UTILIZED IN YIELDING LONG LASTING FLUIDIC TEMPERATURE PROBES.
(FY81) - CONTRACTOR SHALL HAVE FINALIZED TOOL DESIGN FOR BEST METHOD OF NOSING PROJECTILE. INDUCTION STRESS RELIEVING OF THE NOSED BODY SHALL HAVE BEEN ACCOMPLISHED AND EVALUATED. HEAT TREATMENTS SHALL HAVE BEEN VARIED TO IMPROVE FINAL MECHANICAL P ROPERTIES. CONCURRENT WITH THESE INVESTIGATIONS, ALL INTERVENING PROCESSES AND INSPECTION TO THE FINAL ITEM SHALL HAVE BEEN SCRUTINIZED, WITH INVESTIGATION OF PROBLEMS INCURRED AND IMPROVEMENTS MADE WHERE POSSIBLE.
(FY82) - TESTING ON SHORT ROD FRACTURE TOUGHNESS SPECIMENS BY AMMRC SHALL BE EVALUATED BY ARRADCOM FOR INCORPORATION INTO THE ITEM TDP. CONTRACTOR SHALL PURCHASE HIGH FRAGMENTATION STEEL FROM TWO ADDITIONAL SUPPLIERS AND METALLURGICALLY CHARACTERIZI NG THE STEEL. A QUASI-PRODUCTION RUN OF TEST VEHICLES SHALL THEN BE COMPLETED WITH THOROUGH EVALUATION OF DATA GENERATED AN D A FINAL REPORT DELIVERING ALL DATA. NOTE THAT IN QUASI PRODUCTION RUN ALL ITEMS PRODUCED SHALL BE INSPECTED AGAINST END ITEM DRAWINGS AND SPECIFICATION REQUIREMENTS AS VERIFICATION OF PROCESSES.

| EFFORT NO | SUB TASK | SUBTASK TITLE |
|---|---|---|
| 5 4563 | 05 | REDUCTION OF CHIP OXIDATION |

PROBLEM AND SOLUTION

PROBLEM - THE TWO IPFS ESTABLISHED FOR THE LARGE CALIBER STABALLOY PENETRATORS WERE DESIGNED AND FACILITIZED PRIOR TO ANY FULL SCALE PRODUCTION OF THE PENETRATOR. PRODUCTION PROCESSES AND EQUIPMENT REQUIREMENTS WERE BASED PRIMARILY ON DOE EXPERIENCE WITH A SUBSTANTIALLY DIFFERENT DEPLETED URANIUM PRODUCT AND DOE FACILITIES MAKING R+D QUANTITIES OF M774 PENETRATORS. CONSEQUENTLY, BECAUSE THE M774 PENETRATOR HAD NOT BEEN MADE IN QUANTITY AND THE U-0.75 PCT TI ALLOY IS A RELATIVELY NEW ENGINEERING MATERIAL A NUMBER OF UNFORESEEN PROBLEMS IN PRODUCTION HAVE ARISEN WHICH ARE IMPACTING PRODUCTION SCHEDULES AND CAUSING SUBSTANTIAL COST GROWTHS ON PRODUCTION CONTRACTS.

SOLUTION - THIS SUBTASK WILL INCREASE THE YIELD FROM THE CHIP RECYCLING EFFORT BY REDUCING THE AMOUNT OF OXIDE FORMED ON THE CHIP DURING MACHINING. THIS WILL BE ACCOMPLISHED BY OPTIMIZING COOLANT FLOW ON THE WORK PIECE AND MACHINING IN AN INERT ATMOSPHERE. THE WORK WILL FIRST BE DONE WITH MAGNESIUM WHICH BEHAVES SIMILARLY TO URANIUM IN TERMS OF CHIP PYROPHORICITY. AN ENCLOSURE WILL BE DESIGNED FOR MACHINING EQUIPMENT, AND A COOLANT SYSTEM DESIGNED TO PROVIDE OPTIMUM FLOODING OF THE WORKPIECE. VARIOUS INERT GASES WILL BE EVALUATED IN TERMS OF PROTECTION AGAINST OXIDATION, TOOL INSERT LIFE AND COST OF INERT GAS. ONCE THE PROCESS HAS BEEN OPTIMIZED FOR MAGNESIUM, A MINIMUM AMOUNT OF URANIUM WILL BE MACHINED TO DEMONSTRATE THAT ACCEPTABLE RESULTS WILL BE OBTAINED WITH URANIUM.

EFFORT NO. 7482
83/12/09.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 7482 | MODIFIED RIBBON RIFLING GENERATING MACHINE | 79 | 76 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - CURRENT OPERATING PROCEDURE FOR THE PRODUCTION OF A RIFLING BAR OR PROTOTYPE TUBE REQUIRES A RIBBON RIFLING MACHINE TO BE SET UP AT A COST OF 80 HOURS PER SET UP. A COMPLEX MECHANICAL LINKAGE IS USED TO ROTATE THE BAR AS THE MACHINE CARRIAGE MOVES FORWARD, THUS PRODUCING A HELICAL PATH. THIS SET UP TIME REDUCES THE PRODUCTIVE HOURS OF THE MACHINE.

SOLUTION - THERE ARE SEVERAL PROMISING ALTERNATIVES, ANY OF WHICH WILL CONSIDERABLY SIMPLIFY THE ESTABLISHMENT OF THE RIFLING 'SOURCE DATA'. THESE ALTERNATIVES INCLUDE THE USE OF DIGITAL READOUT DEVICES TO ESTABLISH SOURCE DATA IN A FRACTION OF THE TIME AND SPACE CURRENTLY REQUIRED. A SENSITIVE HYDRO-MECHANICAL TRACING SYSTEM WILL BE EMPLOYED.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 7730 | MANUFACTURE OF SPLIT RING BREECH SEALS | 79 | 137 | COMPLETED |
| | | 80 | 363 | APPROVED |
| | | 82 | 108 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - THE SPLIT RING IS A PRECISELY MANUFACTURED COMPLEX ITEM WHICH PROVIDES A GAS SEAL. THE PRESENT MANUFACTURING METHODS HAVE BEEN USED SINCE ITS DEVELOPMENT. THESE METHODS ARE OUT-DATED AND COSTLY, REQUIRING CONSIDERABLE HAND FINISHING BY HIGHLY SKILLED PERSONNEL. THE REJECTION RATE FOR THIS ITEM IS HIGH. FURTHERMORE, IT IS A HIGH REPLACEMENT ITEM DURING THE LIFE OF A WEAPON.
SOLUTION - AUTOMATED AND IMPROVED PROCEDURES WILL BE ADOPTED WHICH WILL MINIMIZE HAND FINISHING OPERATIONS AND NEGATE THE NEED OF HIGHLY SKILLED OPERATORS AND THEREBY REDUCE THE COST. IN FY79 NEW METHODS WILL BE ESTABLISHED FOR SLITTING THE RING REQUIRING LESS STOCK REMOVAL AND SIGNIFICANTLY REDUCING THE SUBSEQUENT OPERATIONS. FY80 FUNDING PURCHASED EQUIPMENT. FY82 FUNDING WILL PROVIDE FOR INSTALLATION AND TESTING.

APPROACH

DESCRIPTION OF WORK -IN ORDER TO REDUCE THE HIGH REJECTION RATE AND LOWER THE DEPENDENCE ON HIGHLY SKILLED PERSONNEL IN THE MANUFACTURE OF SPLIT RING BREECH SEALS, A COMPREHENSIVE EVALUATION OF THE PRESENT MANUFACTURING PROCESSES WAS UNDERTAKEN. THREE PROBLEM AREAS HAVE BEEN IDENTIFIED AND ARE TO BE RESOLVED AS FOLLOWS - A. THE KINK PROVIDES THE TENSION THAT HOLDS THE SPLIT SURFACES TOGETHER. ALL SUBSEQUENT OPERATIONS DEPEND UPON THE UNIFORMITY OF THE KINK. TO RESOLVE THIS PROBLEM A MECHANICAL KINKING UNIT WILL BE DEVELOPED THAT WILL CONSISTENTLY PRODUCE UNIFORM KINKS. THIS UNIT WILL REPLACE A HIGHLY UNRELIABLE MANUAL METHOD NOW IN USE. B. THE ERROR IN THE ANGLE SPLIT IS RELATED TO THE WIDTH OF THE CUTTER WHEEL. IN ORDER TO MINIMIZE THE ERROR, NEW EQUIPMENT WILL BE DEVELOPED THAT WILL SPLIT THE RING WITH A MINIMAL AMOUNT OF STOCK REMOVAL. C. POLISHING THE SPLIT REQUIRES THAT THE OPERATOR POSSESS A GREAT DEAL OF EXPERTISE. THE NEW EQUIPMENT TO BE DEVELOPED WILL ELIMINATE THE NEED FOR HIGHLY SKILLED PERSONNEL. D. SPECIAL TOOLING AND FIXTURING WILL BE INSTALLED AND TESTED THAT WILL HOLD THE RING FOR MACHINING THE ANGLES AND THE INSIDE AND OUTSIDE DIAMETER. THIS MULTIPLE MACHINING CAPABILITY WILL RESULT IN THE CONSOLIDATION AND THE ELIMINATION OF VARIOUS OPERATIONS. E. FY80 - PROCUREMENT ACTION TO ACQUIRE THE EQUIPMENT SPECIFIED IN THE FIRST YEAR OF FUNDING. F. FY81 - EQUIPMENT WILL BE INSTALLED, FIXTURED, AND TESTED. PRODUCTION DATA WILL BE GATHERED AND EVALUATED. REFINEMENT OF FIXTURING AND CHANGES IN THE PRODUCTION PROCESS WILL BE MADE. FINAL REPORT WILL BE PREPARED.

EFFORT NO. 7925
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| * 6 7925 | BORE EVACUATOR BORING | 80 | 111 | COMPLETED |
| | | 81 | 248 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - THE BORE EVACUATOR CHAMBER IS A HOLLOW WELDMENT AND MUST, FOR ASSEMBLY PURPUSES, HAVE TWO MACHINED BORES LOCATED ON A COMMON CENTERLINE. SINCE THE TWO ENDS ARE ABOUT TWO FEET APART AND THE HOLDING SURFACES ARE A NON-UNIFORM WELDMENT, MOVING FROM ONE SETUP TO ANUTHER POSES LOCATION PROBLEMS. FY80 WILL IDENTIFY AND SPECIFY EQUIPMENT THAT WILL PRODUCE THE COMPONENT IN ONE SETUP. ACQUISITION OF THE EQUIPMENT AND TESTING WILL BE ACCOMPLISHED IN FY81.

SOLUTION - PURCHASE EQUIPMENT SPECIFIED IN THE FIRST YEAR?S EFFORT AND TEST UNDER PRODUCTION CONDITIONS. A SPECIAL PURPOSE MACHINE AND TOOLING PACKAGE PROVIDING A HEAD FOR EACH END OF THE EVACUATOR CHAMBER CAN BE DEVELOPED TO PRODUCE BOTH BORES SIMULTANEOUSLY. IF BOTH SURFACES WERE PRODUCED FROM THE SAME SETUP, ORIENTATION OF THE CENTERLINES WOULD BE AUTOMATICALLY ASSURED. A FORM MILL SIMILAR TO A HOB IS ENVISIONED AS THE TOOLING SO THAT WHEN THE BORE DIAMETER IS COMPLETE, ALL OTHER FEATURES OF THE BORE WILL ALSO MEET THEIR DIMENSIONAL REQUIREMENTS.

APPROACH

DESCRIPTION OF WORK - CURRENTLY, THIS OPERATION IS PERFORMED ON A VERTICAL TURRET LATHE (VTL). THE COMPONENT IS APPROXIMATELY 3 FEET LONG AND IS HELD IN THE VERTICAL POSITION TO PROVIDE BORE ACCESS IN THE VTL MACHINE. ONE END OF THE PART IS MACHINED, THEN IT MUST BE REMOVED FROM THE SET UP, TURNED END FOR END, RELOCATED FOR OPPOSITE END MACHINING. IN REALIGNING THE WORKPIECE, THERE IS A CHANCE FOR MISALIGNMENT, AND ATTENDANT COST OF LABOR INVOLVED IN THE MOVE. WE PROPOSE TO REMOVE BOTH PROBLEMS BY DEVELOPMENT OF A DOUBLE END MACHINE FIXTURED TO HOLD THE COMPONENT HORIZONTALLY MAKING BOTH ENDS ACCESSIBLE FOR MACHINING. WITH  WORK HEADS, THE MACHINING CAN BE PERFORMED SIMULTANEOUSLY AND ELIMINATE THE POSSIBILITY OF MISALIGNMENT OF THE TWO (2) BORES. IT WILL ALSO REDUCE THE COST INVOLVED IN MOVING AND REALIGNING THE COMPONENT, AND IT WILL REDUCE OVERALL MACHINING TIME WITH THE DUAL WORK. FY80 FUNDS WILL SET DESIGN PARAMETERS AND PREPARE SPECIFICATIONS. FY81 FUNDING WILL PROVIDE FOR EQUIPMENT ACQUISITION, TESTING, AND A FINAL TECHNICAL REPORT.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 7927 | GENERATION OF BASE MACHINING SURFACES | 80 | 35 | COMPLETED |
| | | 81 | 422 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - STOCK DISTRIBUTION OF FORGED AND CAST MATERIAL AS APPLIED TO CANNON COMPONENTS AND APPLICATION OF LAYOUT PROCESSES TO REDUCE HANDLING OF THE PART FOR LAYING OUT ? HANDLING IN THE MACHINE WHICH THE FIRST CUT WILL BE ESTABLISHED. INORDER TO O BTAIN THE BENEFITS PROJECTED FOR THIS PROGRAM, THE SECOND YEAR?S FUND ING IS REQUIRED.
SOLUTION - USING PRESET LAYOUT TECHNIQUES, SUCH AS OPTICAL SHADOW LAYOUT TEMPLATES, THE COMPONENT CAN BE POSITIONED DIRECTLY ON THE MACHINE TO ESTABLISH THE FIRST CUT ELIMINATING THE INITIAL LAYOUT OPERATION.

APPROACH

DESCRIPTION OF WORK - A PROCEDURE WILL DE DEVELOPED TO COMBINE A SETUP TECHNIQUE WITH AN EFFICIENT MACHINING PROCESS FOR ROUG H FORGINGS AND CASTINGS. THE NEW PROCESS WILL REPLACE THE PRESENT METHOD OF SETTING UP AND LAYING OUT THE WORK IN ONE AREA T HEN PERFORMING AN EQUIVALENT SETUP ON A MACHINE AND THE CONVENTIONAL MACHINING OF WORKING SURFACES TO LAYOUT LINES. PRESET O PTICAL COMPARATOR LAYOUTS AND/OR PRESET HEIGHT GAGING WILL BE EMPLOYED TO SET UP THE FIRST CUTS DIRECTLY ON THE MACHINE ON A ONE TIME BASIS. UPON COMPLETION OF EVALUATIONS, THE ADVANTAGES WILL BE ADOPTED AND THE NECESSARY MACHINES AND TOOLING PURCHA SED AND APPLIED TO THE 105MM M68 BREECH RING PRODUCTION LINE. A FINAL TECHNICAL REPORT WILL BE PREPARED. APPROXIMATELY 50% OF THIS SECOND YEAR EFFORT WILL BE PERFORMED IN HOUSE AND 50% OUT OF HOUSE. FY81 FUNDING WILL SUPPORT ACQUISITION OF ADDITIO NAL TOOL PACKAGES AND COMPLETE TESTING OF ALL SYSTEMS.

| EFFORT NO | SUB TASK | SUBTASK TITLE |
|---|---|---|
| 6 7985 | B | BARREL BROACHING |

PROBLEM AND SOLUTION

PROBLEM - CURRENT GUN BARREL MANUFACTURING PROCEDURES REFLECT ANTIQUATED TECHNOLOGY AND RELY ON MASS REMOVAL OF MATERIAL BY CONVENTIONAL MACHINING METHODS. THE COMMON PRACTICE OF GUN DRILLING, RIFLE BROACHING, AND CONTOUR MACHINING OF BAR STOCK NOT ONLY REPRESENTS A TIME CONSUMING METHOD OF OBTAINING THE GEOMETRY REQUIRED, BUT REQUIRES CONSIDERABLE REMOVAL OF COSTLY MATERIAL TO OBTAIN THE FINISHED PRODUCT. MUCH OF THE EQUIPMENT USED TO PERFORM THESE OPERATIONS REPRESENTS 194D-195D TECHNOLOGY. IN ADDITION, GENERAL CONSENSUS OF INDUSTRY AND GOVERNMENT AGENCIES INDICATE A DIRE NEED FOR UPDATED EQUIPMENT AND NEW PROCESS TECHNOLOGY FOR THE MANUFACTURE OF GUN BARRELS IN THE 20MM TO 40MM SIZE SINCE THE CAPABILITY FOR HIGH PRODUCTION OF THIS RANGE OF BARRELS RESULTS IN A SHORT FALL IN PRODUCTION CAPABILITY REQUIRED TO MEET CURRENT MOB REQUIREMENTS AND PROJECTED PRODUCTION REQUIREMENTS.

SOLUTION - WITHIN THE LAST DECADE, NEW TECHNOLOGY IN THE MANUFACTURE OF GUN BARRELS HAS EMERGED. IN FY80/FY81 THIS PROJECT SUPPORTS THE OPTIMIZATION OF NEW PROCESSES AND THE ESTABLISHMENT OF EQUIPMENT/TOOLING REQUIREMENTS FOR MANUFACTURE OF 5.56MM TO 40MM BARRELS USING THE ROTARY FORGE PROCESS. THE PROJECT ALSO SURVEYED OTHER EXISTING GUN MANUFACTURING OPERATIONS AND PROPOSED ALTERNATE CONCEPTS FOR COST SAVINGS. THIS FY83 PROJECT WILL INVESTIGATE IMPROVED PROCESSES FOR FORMING OF RIFLING IN BARRELS INCLUDING GAIN TWIST BARRELS. BROACH VELOCITY, TOOL CONFIGURATION AND THE LIKE WILL BE OPTIMIZED. ULTRASONIC EXCITATION OF TOOLING WHICH HAS BEEN INVESTIGATED UNDER R?D SUPPORTING PROJECTS WILL BE PUT INTO PRACTICE AND REDUCTIONS IN TIME FOR BROACHING WILL BE DEFINED.

APPROACH

DESCRIPTION OF WORK - FY82 - THIS YEAR WILL INITIATE INVESTIGATION OF IMPROVED CONCEPTS FOR THE FORMING OF RIFLING IN BARRELS. WHILE THE INITIAL FORMATION OF CONSTANT TWIST RIFLING BY ROTARY FORGING OVER GROOVED MANDREL WILL BE CONSIDERED IN PRIOR YEAR?S EFFORT, THIS TECHNIQUE IS NOT APPLICABLE TO GAIN OR VARIABLE TWIST BARRELS, E.G., 20-40MM. EVEN IN CONSTANT TWIST BARRELS OF 30MM SIZES A FINAL BROACHING OPERATION MAY STILL BE REQUIRED TO ACHIEVE DESIRED GROOVE CONFIGURATION. THE BROACHING OPERATION ON A TYPICAL 20MM GAIN TWIST BARREL, PRESENTLY REQUIRING 24 SEPARATE BROACHING OPERATIONS, WILL BE INVESTIGATED USING BREADBOARD BROACHING EQUIPMENT WITH TOOL CHANGES REQUIRED BETWEEN EACH OPERATION. DURING THIS YEAR, METHODS OF REDUCING THE NUMBER OF REQUIRED OPERATIONS WILL BE INVESTIGATED. USING BREADBOARD BROACHING EQUIPMENT MATERIAL REMOVAL WILL BE MAXIMIZED ON A TYPICAL 20MM BARREL. CONCEPTS OF A MULTIPLE WAFER BROACH AND ULTRASONIC EXCITATION OF BROACHES WILL BE EVALUATED FOR POSSIBLE REDUCTION OF BROACHING TIMES. TOOLING DESIGNS AND EQUIPMENT MODIFICATIONS WILL BE SPECIFIED.

FY83 - A PROTOTYPE MACHINE WILL BE FURNISHED AND TESTED IN A CONTRACTOR?S PLANT. THE MACHINE IS TO INCORPORATE THE HIGH LINEAR RATE HYDRAULIC DRIVE DEVELOPED IN FY81 AND FY82.

| EFFORT NO. | TITLE | FY | CUST | STATUS |
|---|---|---|---|---|
| 6 8047 | PASS THRU STEADY RESTS FOR TUBE TURNING | 78 | 139 | COMPLETED |
| | | 80 | 369 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - MACHINING OF CANNON TUBES EXERTS A TRANSVERSE FORCE GREATER THAN THE FULL LENGTH TUBE CAN WITHSTAND. DIMENSIONAL AND SURFACE FINISH REQUIREMENTS ARE IMPOSSIBLE TO OBTAIN WHEN THE TUBE IS UNSUPPORTED AT ITS LONGITUDINAL CENTER. A ROLLER STEADY REST CURRENTLY PROVIDES THE REQUIRED SUPPORT BUT IT ALSO BECOMES AN OBSTACLE TO TURNING THE FULL LENGTH OF THE TUBE IN ONE SETUP. CURRENTLY, IN ORDER TO TURN GUN TUBES, EITHER THE LATHE MUST HAVE TWO CARRIAGES OR TWO SEPARATE LATHES MUST BE PROVIDED AND THE TUBE MOVED FROM MACHINE TO MACHINE.

SOLUTION - A PASS THRU STEADY REST IS NEEDED WITH WILL ALLOW THE CARRIAGE TO MOVE FROM ONE SUPPORTED AREA OF THE TUBE TO THE OTHER WITHOUT DISTURBING THE SET UP. THE DESIGN WILL BE APPLICABLE TO CURRENTLY AVAILABLE EQUIPMENT BUT WILL HAVE EVEN GREATER IMPACT ON NEW EQUIPMENT ACQUISITIONS.

EFFORT NO. 8105
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 8105 | ESTABLISH ROUGH THREAD BLANKS 8 IN. M201 BUSHING | 80 | 88 | COMPLETED |
| | | 81 | 292 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - SINGLE POINT SLOTTING TOOLS ARE CURRENTLY BEING USED TO PRODUCE THE CONFIGURATION OF THE 8' M201 BUSHING STEP THREAD BLANKS. THE STEPS ARE PRODUCED ON AN INSIDE DIAMETER AND ARE SOMEWHAT INACCESSIBLE. THE CUBIC VOLUME OF METAL TO BE REMOVED IS HIGH AND THE CONFIGURATION IS INTRICATE AND REQUIRES A NEW PROCESS THAT WILL REMOVE THE MATERIAL AT AN ACCELARATED RATE. THE MATING COMPONENT ALSO HAS THE SAME CONFIGURATION BUT BECAUSE THE THREADS ARE ON THE OUTSIDE DIAMETER THEY ARE MORE ACCESSIBLE. AGAIN, THE METAL VOLUME TO BE REMOVED IS HIGH. A MACHINING PROCESS IS NEEDED TO REDUCE MACHINING TIME FOR BOTH OF THESE COMPONENTS.
SOLUTION - THERE ARE A NUMBER OF POSSIBLE SOLUTIONS TO THIS PROBLEM. SOME ARE APPLICABLE TO BOTH COMPONENTS WHILE OTHERS ARE LIMITED TO ONE OR THE OTHER COMPONENT. ON FIRST GLANCE, MULTIPLE SLOTTING TOOLS, AN EXTENSION OF THE PRESENT METHOD, WOULD INCREASE PRODUCTIVITY. ALTERNATE SOLUTIONS INCLUDE EDM TRAVELING WIRE, ECM BLANKING AND A COMBINATION OF MILLING AND MULTIPLE SLOTTING.

APPROACH

DESCRIPTION OF WORK - MAKE A COMPLETE EVALUATION OF THE PROCESS OPTIONS, ADDRESSING ECONOMIC BENEFITS AND ADAPTABILITY OF THE PROCESS TO BOTH THE INTERNAL AND EXTERNAL THREAD. OF THE FOUR PROPOSED METHODS, MULTIPLE SLOTTING AND THE COMBINATION OF MILLING AND SLOTTING ARE CONSIDERED THE MOST PROBABLE SOLUTIONS. ECM IS A VERY EFFICIENT METAL REMOVAL PROCESS BUT BECAUSE OF THE CORROSIVE NATURE OF THE PROCESS ITS ACCEPTANCE POSES PROBLEMS. EDM TRAVELING WIRE IS A RELATIVELY NEW PROCESS THAT HAS SOME MERIT BUT BECAUSE OF COMPONENT SHAPES THIS PROCESS WOULD BE LIMITED TO THE BUSHING SO THE TECHNOLOGY DEVELOPED WOULD NOT HAVE THE WIDESPREAD APPLICATION IMPORTANT TO THE PROJECT?S ECONOMIC JUSTIFICATION. FY80 - THE SELECTION EFFORT, TOOL SYSTEM?S DESIGN AND PREPARATION OF EQUIPMENT SPECIFICATIONS. A LIST OF PROSPECTIVE SOURCES OF SUPPLY WILL ALSO BE GENERATED.
FY81 - PURCHASE AND INSTALL THE EQUIPMENT SPECIFIED IN THE PRIOR YEAR?S EFFORT. DURING THE PROCUREMENT LAG THE TOOL SYSTEMS WILL BE CONSTRUCTED IN PREPARATION FOR FINAL TEST OF THE SYSTEM. THE MACHINE WILL BE PRODUCTION TESTED AND THEN SET UP IN THE PRODUCTION LINE. A FINAL REPORT WILL BE PREPARED.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 8246 | IMPROVED FINISHING OF GAS CHECK SEATS | 81 | 60 | COMPLETED |
| | | 82 | 153 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - DUE TO A COMBINATION OF FACTORS AFFECTING THE GRINDING OF THE GAS CHECK SEAT OF THE 155MM M185 GUN TUBE, UNACCEPTABLE ECCENTRICITY EXISTS. THIS IS RELATED TO THE REQUIREMENT OF 80% BEARING SURFACE AT THE GAS CHECK SEAT AND THE TYPE EQUIPMENT USED FOR THE OPERATION. COSTLY REWORK EXCEEDS 30%
SOLUTION - PROVIDE AN IMPROVED PROCESS FOR GAS CHECK SEAT FINISHING BY APPLICATION OF MORE PRECISELY ALIGNED FINISHING EQUIPMENT. THE GAGING SYSTEM WILL ALSO BE REVIEWED.

APPROACH

DESCRIPTION OF WORK - PERFORM AN ENGINEERING ANALYSIS AND SURVEY TO DETERMINE WHAT IS AVAILABLE IN EQUIPMENT SUITABLE TO PERFORM THE SCOPE OF WORK REQUIRED. THE EQUIPMENT DECIDED UPON WILL BE INCORPORATED INTO A DESIGN AND DRAWINGS PREPARED TO PROVIDE GUIDANCE FOR SECOND YEAR FUNDING. MODIFY AND RETROFIT AN EXISTING MACHINE TOOL INTO A SPECIAL GAS CHECK SEAT LAPPING AND FINISHING MACHINE THE MACHINE WILL CONSIST OF A DRIVING AND SUPPORT HEAD, MID SUPPORT REST AND A BREECH END PRECISION ROLLER REST. A PRECISION LAPPING SPINDLE WILL BE DESIGNED SPECIFICALLY FOR THE GAS CHECK SEAT OPERATION AND ADAPTED TO THE MACHINE TOOL ALLOWING FOR REQUIRED TRAVERSING MOTIONS. A FINAL TECHNICAL REPORT WILL SPECIFY THE EQUIPMENT DESCRIPTION AND DESCRIBE IN DETAIL THE OPERATING TECHNEQUES DEVELOPED.

EFFORT NO. 8250
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 8250 | IMPROVED FABRICATION OF RECOIL WEAR SURFACES | 82 | 0 | CANCELLED |
| | | 84 | 28 | APPORTIONMENT |
| | | 85 | 269 | BUDGET |

PROBLEM AND SOLUTION

PROBLEM - PRESENT MACHINING AND OPERATION SEQUENCES, SUCH AS DRILLING, BORING,COUNTERBORING, HONING, TURNING, PLANING AND GRINDING OF RECOIL SYSTEM COMPONENTS, OFTEN RESULT IN SURFACES HAVING UNDESIRABLE TENSILE STRESSES AND LOOSE PARTICLE INCLUSIONS AND PROJECTIONS. HIGH WEAR RATES OF THESE SURFACES PRODUCE EXCESSIVE CONTAMINATION OF HYDRAULIC FLUIDS BY THE LOOSE PARTICLES. THIS, IN TURN, CAUSES SOME COMPONENTS TO BE REJECTED, REWORKED OR SCRAPPED DURING THE SEQUENCE OF OPERATIONS AND AFTER TESTING.

SOLUTION - DEGRADATION OF SURFACES WILL BE AVOIDED BY BETTER CONTROLLING MACHINING PARAMETERS AND MAXIMIZING COMPRESSIVE STRESSES FOR IMPROVED SURFACE INTEGRITY. LOOSE AND WEAK PARTICLES, SUCH AS SWARF AND ABRASIVE PARTICLES FROM A GRINDING WHEEL, WILL BE IDENTIFIED USING X-RAY ANALYTICAL TECHNIQUES AND REMOVED USING ADVANCED METHODS PRIOR TO THE FINAL GRINDING OR HONING OPERATION; AND IN MORE EFFECTIVE FINAL CLEANING AFTER GRINDING AND HONING. HIGH PRESSURE/TURBULENT CLEANING IS ONE OF THE OPTIONS THAT WILL BE GIVEN CONSIDERATION. SOP?S AND PROCESS SPECIFICATIONS WILL BE GENERATED SO THAT ROCK ISLAND ARSENAL WILL GAIN THE MAXIMUM BENEFIT FROM NEW PROCEDURES ADAPTED.

APPROACH

DESCRIPTION OF WORK - IMPROVE MACHINING TECHNIQUES TO GUARANTEE SURFACE INTEGRITY, REDUCE TENSILE STRESSES, MAXIMIZE COMPRESSIVE STRESSES AND BINDING OF MATERIALS MACHINED, AND PROVIDE THE REQUIRED SURFACE FINISH. FY82 - VARIOUS MACHINING OPERATIONS WILL BE INVESTIGATED TO CONTROL THE AMOUNT OF HEAT GENERATED. THIS WILL CONSIDER THE DEPTH OF CUT, AS WELL AS THE EFFECTIVENESS OF THE COOLANT IN DISSIPATING THE HEAT. SINCE ABRASIVE PARTICLES FROM A GRINDING WHEEL BREAK LOOSE AND BECOME ENBEDDED IN THE SURFACE OF THE COMPONENT, THE EFFECT OF SURFACE FINISH AND CUTTING FLUID USED ONTHE DEGREE OF CONTAMINATION WILL ALSO BE INVESTIGATED. FY83 - ADDRESS THE CLEANING OF THE COMPONENTS PRIOR TO ASSEMBLY. HIGH PRESSURE CLEANING WILL BE INVESTIGATED USING BOTH WATER AND SELECTED SOLVENTS TO ESTABLISH ANY BENEFICIAL ACTION ON THE METAL SURFACE. TENSILE AND COMPRESSIVE STRESSES WILL BE DETERMINED THROUGHOUT THE PROGRAM. DURING THE TWO-YEAR PERIOD, SOP?S AND PROCESS SPECIFICATIONS WILL BE GENERATED, AS APPLICABLE, TO REFLECT IMPROVED PRACTICES.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 8341 | HOLLOW CYLINDER CUT OFF MACHINE | 80 | D | CANCELLED |
| | | 81 | 84 | COMPLETED |
| | | 82 | 655 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - ESTABLISHING CYLINDER LENGTH IS ACCOMPLISHED IN ONE OF TWO WAYS, IT IS EITHER PARTED OFF IN A LATHE AND FACED TO LENGTH OR IT IS ROUGH SAWED AND THEN SET UP IN A LATHE FOR FACING TO FINISH LENGTH DIMENSION. IN EITHER CASE, THE OPERATION REQUIRES DOUBLE MEASURING, DOUBLE HANDLING AND SLOW OPERATING PROCEDURES. A NEW APPROACH IS REQUIRED THAT WILL ALLOW FOR ESTABLISHING EXACT LENGTH AND PRODUCE ACCEPTABLE FINISH AND ELIMINATE THE REDUNDANT OPERATIONS.
SOLUTION - A NEW TECHNOLOGY WHEREBY A SET OF ROTATING CUTTERS MILL THE CYLINDER TO EXACT LENGTH LEAVING A SURFACE FINISH WITHIN THAT SPECIFIED FOR CANNON REQUIREMENTS. CURRENTLY AVAILABLE MACHINES WILL NOT ACCOMMODATE TUBE FORGINGS.

APPROACH

DESCRIPTION OF WORK - A NEWLY DEVELOPED METHOD OF CUTTING CYLINDRICAL PARTS HAS BEEN INTRODUCED. THE SYSTEM IS MUCH MORE EFFICIENT THAN SAWING OR PARTING. CURRENT SHELF ITEM EQUIPMENT HAS BEEN DEVELOPED FOR RELATIVELY SMALL AND THIN WALL TUBING. THE SAME TECHNOLOGY EXTENDED TO ACCOMMODATE GUN TUBE LENGTHS AND WALL THICKNESSES WILL IMPROVE PRODUCTIVITY. FY81 - INITIAL PROCESS ENGINEERING AND TESTING OF THE PROCESS ON THICK WALL TUBING AND PREPARATION OF APPLICABLE PROCESS SPECIFICATIONS. FY82 - EQUIPMENT ACQUISITION, INSTALLATION AND TESTING OF THE MACHINE SPECIFIED IN THE FY81 PROGRAM.

EFFORT NO. 8351
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| o 8351 | IMP MFG OF QUADRANT FLATS + MUZZLE BRAKE | 83 | 88 | APPROVED |
| | | 85 | 350 | BUDGET |

PROBLEM AND SOLUTION

PROBLEM - MANY OF THE TUBE ASSEMBLIES PRODUCED AT WATERVLIET ARSENAL HAVE QUADRANT LEVELING FLATS AND MUZZLE BRAKE KEYWAYS THAT HAVE TO BE MACHINED TO CLOSE LOCATION AND TOLERANCE. MOST OF THE CURRENT MANUFACTURING SYSTEMS THAT PRODUCE THESE REQUIREMENTS UTILIZE TWO SETUPS ON TWO MACHINE TOOLS AT TWO MACHINE SITES. MATERIAL HANDLING, FLOOR SPACE AND OPERATIONAL TIME ARE ALL CRITICAL COMMODITIES IN PRODUCTION AREAS.

SOLUTION - AN INVESTIGATION OF THE PRESENT METHOD USED TO HANDLE AND MANUFACTURE THE MUZZLE BRAKE KEYWAY AND THE QUADRANT LEVELING FLATS SHOWS THAT MUCH OF THE CURRENT EQUIPMENT CAN BE RETROFITTED FOR USE WITH A DUAL MACHINING SYSTEM CAPABLE OF MANUFACTURING BOTH THE KEYWAY AND THE LEVELING FLATS IN ONE SETUP. THIS MACHINING SYSTEM WILL USE UPDATED STATE OF THE ART TECHNOLOGIES TO SAVE MATERIAL HANDLING THROUGH AUTOMATIC POSITIONING OF THE GUN TUBE. IN ADDITION, THE MACHINING SYSTEM WILL ALSO SAVE VALUABLE FLOOR SPACE AND OPERATIONAL TIMES.

APPROACH

DESCRIPTION OF WORK - THE PROJECT IS A MULTIPLE YEAR FUNDED PROGRAM WITH THE PRIMARY EFFORT FOCUSED ON THE APPLICATION OF DUAL MACHINING SYSTEMS ON CANNON TUBE MANUFACTURE. THIS WILL INCLUDE THE ENGINEERING, RETROFITTING, SPECIFYING, PROCURING, INSTALLATION AND TEST OF A SPECIALIZED MACHINE TOOL TO PRODUCE THE QUADRANT LEVELING FLAT AND THE MUZZLE BRAKE KEYWAY ON THE 8" M201 AND THE TECHNOLOGICAL EXPERIENCE FOR OTHER TUBE ASSEMBLIES.

FY83 - ESTABLISH AN INDEPTH REVIEW OF THE PRESENT SYSTEM OF MANUFACTURING THE MUZZLE BRAKE KEYWAY AND THE QUADRANT LEVELING FLATS TO DETERMINE WHAT AREAS OF THE EXISTING SYSTEMS CAN BE RETROFITTED AND INCORPORATED INTO A TOTAL STATE OF THE ART DUAL HEAD MACHINING SYSTEM.

FY85 - PURCHASE AND IMPLEMENT MAJOR CAPITAL EQUIPMENT, PERIPHERAL SUPPORT EQUIPMENT AND ALL SPECIALIZED TOOLS THAT WILL BE REQUIRED FOR QUADRANT LEVELING AND MUZZLE BRAKE KEYWAY MACHINERY.

FY87 - INSTALLATION, TESTING, PRODUCTION APPLICATION AND PREPARATION OF THE FINAL REPORT.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 7 3717 | HIGH TEMPERATURE NOZZLE FOR 10KW POWER UNIT | 78 | 339 | COMPLETED |
| | | 80 | 436 | COMPLETED |
| | | 81 | 422 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - HIGH COST OF FABRICATING HIGH TEMPERATURE CERAMIC MATERIALS (I.E., SILICON NITRIDE AND SILICON CARBIDE).
SOLUTION - DETERMINE MANUFACTURING METHODS AND PROCESSES WHICH WILL ELIMINATE EXTENSIVE FINAL FINISHING AND LABOR INTENSIVE PROCESSES BUT CONTINUE TO YIELD A QUALITY PRODUCT TO MEET REQUIREMENTS.

APPROACH

DESCRIPTION OF WORK - TRADE-OFF ANALYSIS. MANUFACTURING METHODS, PROCESSES AND PROJECTED COSTS WILL BE DISCUSSED WITH THE SUPPLIERS OF EACH CERAMIC COMPONENT. COST/PERFORMANCE TRADEOFFS RELATING TO MATERIAL PRODUCTION COSTS WILL BE EVALUATED. PHYSICAL PROPERTY DATA GENERATED FROM COMPLETED R+D IN SUPPORT OF THE PROPOSED PROGRAM WILL BE USED IN CONJUNCTION WITH PROJECTED LIFE IN EROSIVE/CORROSIVE SERVICE TO PREDICT LIFE CYCLE COSTS. TWO OR THREE MANUFACTURING MATERIAL-METHOD COMBINATIONS FOR EACH COMPONENT WILL BE SELECTED FOR FURTHER STUDY AND BE PROCURED IN A CONDITION REPRESENTATIVE OF THE MANUFACTURING METHOD SELECTED AND EVALUATED BY RIG TESTS. RIG TESTS INCLUDE THE EVALUATION OF DESIGN ALTERNATIVE AND CONFIRM THE PREDICTED LIFE OF THE NOZZLE SECTION UNDER EROSIVE/CORROSIVE CONDITIONS, AND INCLUDE TYPICAL ENGINE TEST CONDITIONS. A MINIMUM OF TWO AND A MAXIMUM OF THREE MATERIAL-MANUFACTURING METHOD COMBINATIONS WILL BE CARRIED FORWARD IN 4 STEPS- 1. PRELIMINARY WORK ON CERAMIC COMPONENT MANUFACTURE. 2. MANUFACTURING METHODS FOR SELECTED COMPONENT MANUFACTURING PROCESS. 3. ASSEMBLY METHODS. 4. QUALITY CONTROL.
ASSEMBLY METHODS FOR THE COMPONENTS AND POST-ASSEMBLY FABRICATION METHODS WILL BE ESTABLISHED. COMPONENT ASSEMBLY MAY BE PERFORMED BY THE CERAMIC SUPPLIER OR THE ENGINE MANUFACTURER, BUT THE POST-ASSEMBLY FABRICATION WILL BE BY THE ENGINE MANUFACTURER. QUALITY CONTROL METHODS TO EVALUATE COMPONENTS AND ASSEMBLY OF TURBINE NOZZLE SECTION WILL BE ESTABLISHED TO PROVIDE INCOMING AND IN-PROGRESS CHECKS ON QUALITY. RADIOGRAPHY, ACOUSTIC EMISSION, AND DYE PENETRANT METHODS WILL BE USED WITH SUPPORT FROM DENSITY, DIMENSIONAL, SURFACE CONDITION AND OTHER TECHNIQUES AND INCORPORATED INTO ACCEPTANCE SPECIFICATIONS AFTER REVIEW WITH CERAMIC SUPPLIER.
ENGINE TEST - THREE ?LOTS? OF CERAMIC NOZZLES WILL BE MANUFACTURED USING A MIXTURE OF COMPONENTS PRODUCED FROM A MINIMUM OF TWO LOTS, AND WILL ESTABLISH INTERCHANGEABILITY OF COMPONENTS, DAY-TO-DAY REPRODUCIBILITY OF COMPONENT MANUFACTURE AND OF ASSEMBLY METHODS, AND POSSIBLE MANUFACTURING PROBLEMS TO BE EXPECTED WITH PRODUCTION ENGINES. ENGINE TEST WILL BE CONDUCTED ON ONE NOZZLE FROM EACH OF THREE LOTS. AT THE COMPLETION OF THE TESTS TO DETERMINE PERFORMANCE CHARACTERISTICS, LIFE TESTS WILL BE CONDUCTED TO RELATE ENGINE PERFORMANCE (POWER, OUTPUT, EXHAUST TEMPERATURE, PRESSURE DROP, ETC.) TO THE AMOUNT OF STANDARD DUST INGESTED (E.G., ARIZONA ROAD DUST). PLOTS OF DUST INGESTION VERSUS PERFORMANCE WILL BE MADE FOR THE ALL-METAL ENGINE AND FOR THE CERAMIC NOZZLE ENGINE. ENGINE OR RIG TESTS WILL BE EXTENDED TO HIGHER TEMPERATURES. REPEAT ENGINE OPERATION TESTS WILL BE PERFORMED AT 1950 DEGREES F. INLET TEMPERATURE TO EVALUATE THE NOZZLE SECTION FOR USE IN A 15KW OUTPUT MACHINE.

## LASER DRILLING PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| T 82 6057-04 | THERMAL CUTTING OF TRACKED COMBAT VEHICLE PARTS | APPROVED | 328 |
| 4 84 6057-04 | THERMAL AND MECHANICAL CUTTING AND BEVELING ARMOR PLATE | APPORTIONMENT | 720 |
| 4 85 6057-04 | THERMAL AND MECHANICAL CUTTING AND BEVELING | BUDGET | 2075 |
| T 81 6057-13 | LASER CUTTING | COMPLETED | 23 |
| T 82 6057-13 | LASER CUTTING | APPROVED | 258 |
| 4 83 6057-13 | LASER CUTTING OF TRACKED COMBAT VEHICLE PARTS | APPROVED | 40 |
| 4 84 6057-13 | LASER CUTTING OF TRACKED COMBAT VEHICLE PARTS | APPORTIONMENT | 300 |
| 4 85 6057-13 | LASER CUTTING | BUDGET | 300 |
| 4 83 6079-05 | AUTOMATED LASER DRILLING OF COMBUSTOR COMPONENTS | APPROVED | 420 |

## ADAPTIVE CONTROL PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 1 84 7471 | PROCESS CONTROL SYSTEM FOR N/C AND CNC MACHINES | APPROVED | 100 |
| 1 85 7471 | PROCESS CONTROL SYSTEM FOR N/C AND CNC MACHINES | BUDGET | 300 |
| 4 83 6095-01 | MACHINING AND ADAPTIVE CONTROL | APPROVED | 31 |
| 4 84 6095-01 | MACHINING AND ADAPTIVE CONTROL | APPORTIONMENT | 200 |
| 4 85 6095-01 | MACHINING AND ADAPTIVE CONTROL | BUDGET | 195 |
| 6 81 8120 | ADAPTIVE CONTROL TECHNOLOGY (CAM) | COMPLETED | 60 |
| 6 83 8120 | ADAPTIVE CONTROL TECHNOLOGY (CAM) | APPROVED | 495 |
| 6 85 8120 | ADAPTIVE CONTROL TECHNOLOGY (CAM) | BUDGET | 200 |
| 6 81 8135 | IN-PROCESS CONTROL OF MACHINING | APPROVED | 746 |
| 6 82 8135 | IN-PROCESS CONTROL OF MACHINING | APPROVED | 841 |

## DIAGNOSTIC PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| T 81 6057-05 | MACHINE DIAGNOSTICS | COMPLETED | 22 |
| T 82 6057-05 | MACHINE DIAGNOSTICS | APPROVED | 258 |
| 4 83 6057-05 | MACHINE DIAGNOSTICS | APPROVED | 25 |
| 4 84 6057-05 | MACHINE DIAGNOSTICS | APPORTIONMENT | 700 |
| 4 85 6057-05 | MACHINE SYSTEM DIAGNOSTICS | BUDGET | 420 |

## DEBURRING PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 6 82 8346 | DEBURRING OF BORE EVACUATOR HOLES | APPROVED | 224 |
| 6 83 8346 | DEBURRING OF BORE EVACUATOR HOLES | UNFUNDED | 237 |

| EFFORT NO | SUB TASK | SUBTASK TITLE |
|---|---|---|
| 4 6057 04 | | THERMAL CUTTING OF TRACKED VEHICLE PARTS |

PROBLEM AND SOLUTION

PROBLEM - IMPROVE MATERIALS AND MANUFACTURING PROCESSES EMPLOYED FOR THE MANUFACTURE OF XM1 BY INCORPORATING NEW MANUFACTURING PROCESSES AND TECHNOLOGIES TO THE CURRENT SYSTEM. THESE PROCESSES AND TECHNOLOGIES THROUGH BETTER MATERIALS, IMPROVED FABRICATION, ADVANCED QUALITY CONTROL TECHNIQUES AND REDUCED LABOR-INTENSIVE MANUFACTURING OPERATIONS, WILL ENABLE THE XM1 TO BE MANUFACTURED MORE ECONOMICALLY, ACHIEVE IMPROVED PERFORMANCE, LOWER LIFE CYCLE COSTS AND PROVIDE SHORTER LEAD TIMES AND IMPROVED READINESS FOR MOBILIZATION.

SOLUTION - INCORPORATE NEW MANUFACTURING PROCESSES AND TECHNOLOGIES INTO THE XM1 SYSTEM INCLUDING THE FOLLOWING TASKS - MONOCRYSTAL ALLOY FOR HIGH PRESSURE TURBINE BLADES, RAPIDLY SOLIDIFIED RATE (RSR) NICKEL-BASE SUPERALLOY FOR HIGH PRESSURE DISK, AUTOMATED METALLIZING, THERMAL CUTTING, MACHINE SYSTEM DIAGNOSTICS, METROLOGY, BI-CAST HP (HIGH PRESSURE) TURBINE NOZZLE, CERAMIC COMBUSTOR, COMPOSITE TURRET BASKET, COMPOSITE TOW BARS, THERMALLY ASSISTED MACHINING, AND COMPUTER SIMULATION.

APPROACH

DESCRIPTION OF WORK - TASK 4 WILL ESTABLISH AND OPTIMIZE PARAMETERS FOR LASER CUTTING HIGH HARDNESS ARMOR IN COMPLEX SHAPES ( HOLES, CHANTERS, ETC.,). EXAMINE THE OPTIMIZATION OF BEVELING ARMOR IN THICKNESS 1' AND GREATER TOWARDS INCREASED SPEED, IMPROVING ACCURACY AND MINIMIZING DISTORTION. SELF IMPLEMENTATION WILL BE ASSURED BY PROVIDING A PROTOTYPE SYSTEM FOR USE IN PRODUCTION. BENEFITS ACHIEVED, COMBINED WITH BRIEFINGS AND DEMONSTRATIONS, WILL PROVIDE THE IMPETUS FOR FURTHER IMPLEMENTATION .

SUBTASK NO. 4 6057 13
84/02/17.

| EFFORT NO | SUB TASK | SUBTASK TITLE |
|---|---|---|
| * 4 | 6057 13 | LASER CUTTING OF TRACKED COMBAT VEHICLE PARTS |

PROBLEM AND SOLUTION

PROBLEM - DETAIL PIECES FOR ARMOR VEHICLES ARE CONVENTIONALLY PREPARED BY THERMAL CUTTING METHODS CREATING PROBLEMS DUE TO HEAT AFFECTED ZONES AND ACCURACY OF CUT. IN ABRAMS TANK PRODUCTION SPECIFIC PROBLEMS EXIST IN ACCURACY AND QUALITY OF FUEL GAS-OXYGEN CUTTING OF HEAVY ARMOR PLATE AND IN ACCURACY AND THERMAL EFFECTS ON LIGHT GAUGE HIGH HARDNESS ARMOR.

SOLUTION - ONE METHOD OF THERMAL CUTTING, LASER BEAM TORCH, HAS DEMONSTRATED THE ABILITY TO PRODUCE MORE ACCURATE CUTS WITH LESS KERF AND LESS HEAT EFFECTS. IN SOME APPLICATIONS, LASER BEAM CUTTING HAS DEMONSTRATED THE ABILITY TO ACHIEVE THESE BENEFITS AT HIGHER CUTTING SPEED THAN IS ATTAINABLE WITH OXYGEN-FUEL GAS. THE PROGRAM WILL BE ADDRESSED IN SEVERAL TASKS. ONE WILL ADDRESS HIGH HARDNESS ARMOR CUTTING. OTHERS WILL ADDRESS CUTTING ARMOR STEEL, SHEET, AND PLATE LESS THAN ONE INCH IN THICKNESS AND OTHER MATERIALS. THE PROGRAM WILL DETERMINE THE APPLICABILITY OF THE LASER TO ARMOR CUTTING, AND WILL ESTABLISH PARAMETERS AND A PROTOTYPE SYSTEM TO DEMONSTRATE USABILITY AND BENEFITS FOR EACH TASK.

APPROACH

DESCRIPTION OF WORK - THIS PROGRAM WILL ESTABLISH AND OPTIMIZE THE PARAMETERS FOR LASER CUTTING HIGH HARDNESS ARMOR IN COMPLEX SHAPES (HOLES, CHAMFERS, ETC.,). THE OPTIMIZATION SHALL BE CONCERNED WITH SPEED OF CUT, EXTENT OF HEAT AFFECTED ZONE, DISTORTION EFFECTS, AND ACCURACY. PHASE I WILL RESULT IN THE SELECTION OF A SUBCONTRACTOR WITH LASER TECHNOLOGY, DESIGN OF EQUIPMENT TO LASER CUT ARMOR STEEL, PLATE, AND SHEET, AND THE PREPARATION OF A FACILITY FOR LASER CUTTING.

PHASE II - FABRICATE A PROTOTYPE SYSTEM TO LASER CUT ARMOR MATERIALS. INSTALL THE PROTOTYPE SYSTEM IN A PRODUCTION FACILITY, DETERMINE PROCEDURES FOR LASER CUTTING, AND VALIDATE CAPABILITY TO PRODUCE PRODUCTION PARTS.

PHASE III - IMPLEMENT THE PROTOTYPE LASER CUTTING EQUIPMENT INTO PRODUCTION FOR THE MANUFACTURING OF COMBAT VEHICLE PARTS FROM ARMOR STEEL, AND PROVIDE DETAILED REPORTS THAT SUMMARIZE ACCOMPLISHMENTS, PROVIDE DATA AND SPECIFICATIONS WHICH WILL ENABLE RESULTS TO BE DUPLIATED ELSEWHERE. BRIEFINGS AND DEMONSTRATIONS WILL ALSO BE PROVIDED TO ASSURE THAT THE TECHNOLOGY IS TRANSFERRED TO ALL WHO MAY BENEFIT FROM IT.

SUBTASK NO. 4 6079 05
84/02/17.

| EFFORT NO | SUB TASK. | SUBTASK TITLE |
|---|---|---|
| 4 6079 | 05 | AUTOMATED LASER DRILLING OF COMBUSTOR COMPONENTS |

PROBLEM AND SOLUTION

PROBLEM - TYPICALLY, COMBUSTORS OF TURBINE ENGINES ARE SHEET METAL COMPONENTS WITH A MULTITUDE OF SMALL DIAMETER COOLING AIR HOLES. THE AGT-1500 COMBUSTOR SCROLL, BECAUSE OF THE UNIQUE ENGINE CONFIGURATION, HAS A VERY COMPLEX GEOMETRY OF COMPOUND CURVATURE. THE FABRICATION OF THIS COMPONENT IN A CONVENTIONAL METHOD REQUIRES LOCATING AND MECHANICAL DRILLING OF EACH OF THE MANY COOLING HOLES INDIVIDUALLY.

SOLUTION - MULTIPLE OR AUTOMATED HOLE DRILLING UTILIZING LASERS OFFERS A SUBSTANTIAL IMPROVEMENT IN THE FABRICATION OF THESE COMPONENTS.

APPROACH

DESCRIPTION OF WORK - ADDRESS THE FORMING AND DRILLING PROCESS AND DEVELOP A MANUFACTURING TECHNIQUE WHICH WILL ELIMINATE THE RESTRICTIONS AND REQUIREMENT TO DRILL INDIVDUAL HOLES CONVENTIONALLY. VARIOUS COMMERCIALLY AVAILABLE LASER UNITS WILL BE EVALUATED FOR COST EFFECTIVENESS. THE OPERATING PARAMETERS WILL BE OPTIMIZED TO YIELD SMOOTH FINISHED STRAIGHT AND ANGULAR HOLES WITH CONSISTENCY AND RELIABILITY. PREDRILLING OF HOLE PATTERN PRIOR TO FORMING WILL BE INVESTIGATED AS WELL AS AUTOMATED LASER DRILLING OF FINISH FORMED COMPONENTS. THE MOST ECONOMICAL PROCESS WILL BE OPTIMIZED FOR PRODUCTION APPLICATION.

EFFORT NO. 7471
83/11/17.

| | EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|---|
| * 1 | 7471 | PROCESS CONTROL SYSTEM FOR N/C AND CNC MACHINES | 84 | 100 | APPORTIONMENT |
| | | | 85 | 300 | BUDGET |

PROBLEM AND SOLUTION

PROBLEM - PRESENT PROCESS CONTROL SYSTEM FOR N/C AND CNC MACHINES DO NOT INCLUDE REAL-TIME MONITORING AND FEEDBACK COMPENSATION SUCH AS MATERIAL HARDNESS, DEPTH OF CUT, MATERIAL COMPOSITION, TOOL WEAR, AND EXPERIENCE OF THE OPERATOR/PROGRAMMER WHICH CAN REDUCE MACHINING TIME. BOTH IN-PROCESS INSPECTION AND ADAPTIVE CONTROL SYSTEMS ARE AVAILABLE FOR DRILLING AND MILLING APPLICATIONS.

SOLUTION - A STATISTICAL PROCESS CONTROL SYSTEM (INCLUDING REQUIRED SOFTWARE) CAPABLE OF PERFORMING REAL-TIME PROCESS CONTROL ANALYSIS DURING THE MACHINING OPERATION WILL BE INTEGRATED ON N/C AND CNC MACHINES. THE CONTROL SYSTEM WOULD USE IN-PROCESS GAGING AND ADVANCED ELECTRONIC ADAPTIVE CONTROL SYSTEM (INCLUDING SENSORS) TO PERFORM QUALITY CHECKS DURING THE MACHINE CYCLE.

APPROACH

DESCRIPTION OF WORK - FY84 - PROCURE PROCESS SENSORS, SUCH AS ACCELEROMETERS, DYNAMOMETERS, THERMOCOUPLES, TEMPERATURE-FLOW CONTROLLERS, ETC. PROCURE GAGING AND OTHER IN-LINE INSPECTION EQUIPMENT. ASCERTAIN FEASIBILITY OF VISION SYSTEMS FOR OTHER IN-PROCESS INSPECTIONS. INTEGRATE SENSORS AND GAGING INTO A CANDIDATE N/C OR CNC MACHINE. PERFORM IN-HOUSE TECHNICAL WORK.

FY85 - SELECT CANDIDATE N/C OR CNC MACHINE FOR SYSTEM INSTALLATION. PROCURE ADAPTIVE CONTRULLER. PROCURE SOFTWARE TO ADJUST MACHINING PROCESS PARAMETERS UTILIZING A FEEDBACK LOUP BASED ON SENSOR AND GAGING OUTPUT, DEBUG SYSTEM. PROVE OUT SYSTEM AND SOFTWARE, EVALUATE SYSTEM AND COST EFFECTIVENESS. PREPARE FINAL TECHNICAL REPORT AND CONDUCT TECHNICAL BRIEFINGS AND DEMONSTRATION.

SUBTASK NO. 4 6D95 D1
84/02/17.

| EFFORT NO | SUB TASK | SUBTASK TITLE |
|---|---|---|
| 4 6095 | 01 | MACHINING AND ADAPTIVE CONTROL |

PROBLEM AND SOLUTION

PROBLEM - A NUMBER OF TECHNOLOGICAL AREAS HAVE BEEN IDENTIFIED WHICH CAN BE APPLIED AS COST REDUCING MEASURES OR AS A MEANS O F IMPROVING THE MANUFACTURE COST OF THE M1 ABRAM TRANSMISSION.
SOLUTION - THIS PROGRAM WILL BE SEPERATED INTO FOUR TASKS, EACH ADDRESSING A SPECIFIC TECHNOLOGICAL AREA - MACHINING AND ADAP TIVE CONTROL, BI-METAL PARTS, SURFACE TREATMENT AND HARDENING, AND METROLOGY. THIS PROJECT WILL GENERATE A SEPARATE FINAL RE PORT FOR EACH TASK, PILOT HARDWARE AND/OR CHANGES TO THE TECHNICAL DATA PACKAGE AS APPROPRIATE TO ACCOMODATE IMPLEMENTATION.

APPROACH

DESCRIPTION OF WORK - DEVELOP PILOT SYSTEMS UTILIZING OFF-THE-SHELF HARDWARE. THESE SYSTEMS WILL BE SET UP IN-PLANT OFF-LINE , TO PRODUCE PRODUCTION COMPONENTS. IT IS INTENDED THAT THIS EFFORT DEAL ONLY WITH OFF-THE-SHELF EQUIPMENT. ADAPTIVE CONTRO L NEEDS THAT CANNOT BE MET WITH OFF-THE-SHELF EQUIPMENT WILL BE DIRECTED TO AND INTERFACED WITH PROJECT T836D41 ENTITLED 'INT EGRATED APPLICATIONS OF ADAPTIVE CONTROL FOR MACHINE TOOLS AND ROBOTS'. THIS PROJECT ADDRESSES ADAPTIVE CONTROL ON A WIDER S COPE AND COULD PROVIDE THE SUPPORT NEEDED TO DEAL WITH REQUIREMENTS NOT MET WITH OFF-THE-SHELF SENSORS AND HARDWARE.
PERFORM SYSTEM DE-BUG AND START-UP, AND THE PROCESS ENGINEERING NEEDED TO IMPLEMENT THESE TECHNOLOGIES ON THE X-1100 TRANSMIS SION LINE, ALONG WITH AN ECONOMIC OPTIMIZATION STUDY.

EFFORT NO. 8120
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 8120 | ADAPTIVE CONTROL TECHNOLOGY (CAM) | 81 | 60 | COMPLETED |
| | | 83 | 495 | APPROVED |
| | | 85 | 200 | BUDGET |

PROBLEM AND SOLUTION

PROBLEM - CONVENTIONAL GRINDING PROCESSES DO NOT UTILIZE THE INHERENT CUTTING EFFICIENCIES OF THE GRINDING WHEEL. PRECISION TOLERANCES ARE DIFFICULT TO HOLD DUE TO PART HEATING WHILE GRINDING. PRODUCTIVITY IS LIMITED BY WHEEL WEAR RATES THAT INCREASE EXPONENTIALLY AS FEED RATE INCREASES.
SOLUTION - USE AN ADAPTIVELY CONTROLLED GRINDING PROCESS DEVELOPED BY A COMPANY CALLED ENERGY ADAPTIVE GRINDING INC. THIS PROCESS INVOLVES THE USE OF A REHABILITATED CYLINDRICAL GRINDING MACHINE WHICH HAS BEEN RETROFITTED W?TH AN ADAPTIVE CONTROL SYSTEM WHICH CONTROLS THE WHEEL SPEED ? EFFECTIVELY CONTROLS THE SHARPNESS OF THE WHEEL AND MAINTAINS A HIGH WHEEL CUTTING EFFICIENCY.

APPROACH

DESCRIPTION OF WORK - WORK ON THIS PROJECT WILL CONSIST OF A N ENGINEERING EVALUATION OF THE ENERGY ADAPTIVE CONTROL CONCEPTS OF CYLINDRICAL GRINDING TO INCLUDE CONTACTS WITH USERS AND THE MANUFACTURER OF THE EQUIPMENT. THE RESULTS WILL ASSIST IN PREPARING SPECIFICATIONS FOR THE PROCUREMENT OF SERVICES NECESSARY TO CONVERT A CYLINDRICAL GRINDER AT WATERVLIET ARSENAL FROM CONVENTIONAL GRINDING TO ENERGY ADAPTIVE GRINDING. FUNDING FOR FY83 AND FY85 WILL PROCURE, INSTALL, TEST AND PROTOTYPE PRODUCTION AN ENERGY ADAPTIVE GRINDING MACHINE.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 8135 | INPROCESS CONTROL OF MACHINING | 81 | 746 | APPROVED |
| | | 82 | 841 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - MANUFACTURE OF HOWITZER RECOIL COMPONENTS REQUIRING CLOSE-TOLERANCE, COMPLEX-CONTOUR ORIFICE AREAS IS EXCESSIVELY SLOW AND COSTLY. REJECTIONS, AND REWORK ARE HIGH. STRESSES AND DISTURTION OF THESE FLEXIBLE WORKPIECES MAKE MACHINING SLOW AND HOLDING OF TOLERANCES DIFFICULT.
SOLUTION - IN THE FIRST YEAR, FY81, OF THIS TWO-YEAR EFFORT, THE INTEGRATION OF MACHINING AND INSPECTION BY COMPUTER WILL BE STARTED TO PERMIT DIRECT ADJUSTMENT AND CONTROL OF ORIFICE AREAS DURING MILLING. NC TOOL PATHS WILL BE AUTOMATICALLY CORRECTED TO ELIMINATE MACHINE TOOL ERRORS, AND TO CONTROL ORIFICE AREAS TO BE CUT. IN-PROCESS GAUGING WILL BE APPLIED TO CONTROL TOOL DEFLECTION AND PATHS DURING MACHINING. IN THE SECOND YEAR, FY82, SIMILAR CONTROLS WILL BE APPLIED IN TURNING AND BORING, AND THE INTEGRATION WILL BE COMPLETED TO INTERACTIVELY CONTROL CROSS-SECTIONAL AREAS OF THE RECOIL ORIFICES.

APPROACH

DESCRIPTION OF WORK - FY81 - VARIOUS IN-PROCESS AUTOMATIC GAUGING AND COMPUTERIZED SERVO-CONTROL FEEDBACK SYSTEMS WILL BE TESTED AND EVALUATED. AN IN-PROCESS GAUGING SYSTEM WILL BE SELECTED TO MINIMALLY PROVIDE INTERMITTENT AND/OR CONTINUOUS MEASUREMENT OF TOOL PATH WITH RESPECT TO THE NUMERICAL-CONTROL (NC) PROGRAM AND WORKPIECE. THE COMPUTERIZED FEEDBACK CONTROL SYSTEM WILL BE SELECTED, IN CONJUNCTION WITH THE NC PROGRAMMED TOOL PATHS, AND ELIMINATION OF OUT-OF-TOLERANCE CONDITIONS OCCURRING BY AUTOMATIC FEED STOP AND CONTROLLED RETRACTION. THE IN-PROCESS GAUGING/FEEDBACK CONTROL SYSTEM WILL BE RETROFITTED TO A PRECISION MILLING MACHINE AND ADJUSTED FOR MAXIMUM CAPABILITY OF CONTINUOUSLY MEASURING THE AREA BEING GENERATED BY THE CUTTING, AND AUTOMATICALLY ADJUSTING THE TOOL PATH WITHIN THE DESIGN ALLOWANCES AND TOLERANCED, TO PROVIDE ACCURATE CONTROL OF NOT ONLY THE POINT-TO-POINT DIMENSIONS BUT ALSO THE OVERALL AREA OF THE ORIFICE BEING MACHINED. EXISTING COMPUTERIZED MEASURING EQUIPMENT WILL BE USED, IN CONJUNCTION WITH COMPUTERIZED DESIGN AND GRAPHICS EQUIPMENT, TO INSPECT THE MACHINED ORIFICES, AND TO NC PROGRAM AND ADJUST THE CONTROL SYSTEMS FOR VARIOUS ORIFICE DESIGNS AND RESPECTIVE TOLERANCES.

SUBTASK NO. 4 6057 05
84/02/17.

| EFFORT NO | SUB TASK | SUBTASK TITLE |
|---|---|---|
| * 4 | 6057 05 | MACHINE DIAGNOSTICS |

PROBLEM AND SOLUTION

PROBLEM - IMPROVE MATERIALS AND MANUFACTURING PROCESSES EMPLOYED FOR THE MANUFACTURE OF XM1 BY INCORPORATING NEW MANUFACTURING PROCESSES AND TECHNOLOGIES TO THE CURRENT SYSTEM. THESE PROCESSES AND TECHNOLOGIES THROUGH BETTER MATERIALS, IMPROVED FABRICATION, ADVANCED QUALITY CONTROL TECHNIQUES AND REDUCED LABOR-INTENSIVE MANUFACTURING OPERATIONS, WILL ENABLE THE XM1 TO BE MANUFACTURED MORE ECONOMICALLY, ACHIEVE IMPROVED PERFORMANCE, LOWER LIFE CYCLE COSTS AND PROVIDE SHORTER LEAD TIMES AND IMPROVED READINESS FOR MOBILIZATION.

SOLUTION - INCORPORATE NEW MANUFACTURING PROCESSES AND TECHNOLOGIES INTO THE XM1 SYSTEM INCLUDING THE FOLLOWING TASKS - MONOCRYSTAL ALLOY FOR HIGH PRESSURE TURBINE BLADES, RAPIDLY SOLIDIFIED RATE (RSR) NICKEL-BASE SUPERALLOY FOR HIGH PRESSURE DISK, AUTOMATED METALLIZING, THERMAL CUTTING, MACHINE SYSTEM DIAGNOSTICS, METROLOGY, BI-CAST HP (HIGH PRESSURE) TURBINE NOZZLE, CERAMIC COMBUSTOR, COMPOSITE TURRET BASKET, COMPOSITE TOW BARS, THERMALLY ASSISTED MACHINING, AND COMPUTER SIMULATION.

APPROACH

DESCRIPTION OF WORK - TASK 5 WILL IDENTIFY MACHINE SYSTEMS AND WORK WITH THE MACHINE BUILDER AND USER TO IDENTIFY PROBABLE FAILURE MODES. A COMPUTER MODEL, TO ASSEMBLE HISTORICAL DATA, AND A FIRST-CUT MAINTENANCE PROGRAM WILL BE ESTABLISHED WITH CAPABILITY OF BUILDING IN A DATA BASE OF EXPERIENCE. ALSO, SENSORS THAT CAN INDICATE PROBLEMS IN MACHINE PERFORMANCE WILL BE IDENTIFIED AND INCORPORATED IN THE SYSTEM SO AS TO UPDATE AND REFINE THE MAINTENANCE PLAN.

EFFORT NO. 8346
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 8346 | DEBURRING OF BORE EVACUATOR HOLES | 82 | 224 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - THE INABILITY TO SUCCESSFULLY AND CONSISTENTLY MECHANICALLY PROVIDE A SMOOTH RADIUS TO THE INTERNAL OPENING OF THE BORE EVACUATOR HOLES OF THE 120MM XM256 TANK GUN HAS LED TO EARLY CHROMIUM FAILURE IN THAT AREA OF THE TUBE. THERE IS A SIMILAR PROBLEM WITH ALL CANNON TUBES WHICH HAVE BORE EVACUATORS, SUCH AS 155MM M185 AND 105MM M67.
SOLUTION - AN INTERNAL FIXTURE, ACTING AS A CARRIER FOR THE ANODE AND SOLUTION WILL BE DESIGNED AND FABRICATED. THE UNIT WILL BE CAPABLE OF SELECTIVELY ELECTROCHEMICALLY POLISHING SHARP BORE EVACUATOR HOLES.

APPROACH

DESCRIPTION OF WORK - DESIGN AND FABRICATE AN INTERNAL WORKING HEAD THAT WILL PROVIDE THE SOLUTION AND CURRENT TO REMOVE THE NODULES AND EXCESS METAL IN THE CRITICAL AREA IN THE FOLLOWING MANNER - (1) LOCATE TO THE CRITICAL AREA FROM THE BREECH FACE. (2) LOCATE FROM THE MUZZLE FACE. (3) INDEX EXTERNALLY THROUGH THE BORE EVACUATOR HOLES. (4) COMBINATION OF THE ABOVE.
THE DESIGN WILL BE TESTED USING STUB TUBES, SHORTER IN LENGTH BUT BASICALLY IDENTICAL IN I.D. DIMENSIONS AND GEOMETRY. BASED ON THE PERFORMANCE AND TEST DATA A FULL SCALE MODEL WILL BE FABRICATED AND TESTED ON PRODUCTION TUBES.

## ELECTROCHEMICAL MACHINING PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 6 84 7985-F | TRAVELING ELECTRODE ECM RIFLING | APPROVED | 225 |
| 6 85 7985-F | TRAVELING ELECTRODE ECM RIFLING | BUDGET | 500 |

## IMPROVED TOOLING PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 1 80 7302 | PRODUCTION OF BORIDE COATED LONG LIFE TOOLS | UNFUNDED | 200 |
| 1 81 7302 | PRODUCTION OF BORIDE COATED LONG LIFE TOOLS | CANCELLED | 0 |
| 1 82 7302 | PRODUCTION OF BORIDE COATED LONG LIFE TOOLS | UNFUNDED | 60 |
| 1 83 7302 | PRODUCTION OF BORIDE COATED LONG LIFE TOOLS | CANCELLED | 0 |
| 1 84 7302 | PRODUCTION OF BORIDE COATED LONG LIFE TOOLS | APPROVED | 400 |
| 7 81 8190 | MMT IMPROVED BLISK-IMPELLER CUTTER LIFE | COMPLETED | 225 |
| 7 82 8190 | IMPRVD CUTTER LIFE, T-700 COMP BLISK/IMPELLER MILLING OPER | APPROVED | 486 |
| 6 82 8248 | APPLICATION OF HIGH-RATE CUTTING TOOLS | APPROVED | 102 |
| 6 84 8439 | IMPROVED RIFLING PROCEDURES | APPROVED | 80 |

## FLEXIBLE MANUFACTURING SYSTEM PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| T 79 5082 | FLEXIBLE MACHINING SYSTEMS PILOT LINE FOR TCV COMPONENTS | COMPLETED | 904 |
| T 80 5082 | FLEXIBLE MACHINING SYSTEM, PILOT LINE FOR TCV COMPONENTS | COMPLETED | 857 |
| T 81 5082 | FLEXIBLE MACHINING SYSTEM, PILOT LINE FOR TCV COMPONENTS | APPROVED | 779 |
| T 82 5082 | FLEXIBLE MACHINING SYSTEM, PILOT LINE FOR TCV COMPONENTS | APPROVED | 750 |
| 4 83 5082 | FLEX MACHINING SYS (FMS) PILOT LINE F/TLV COMPS (CAM) (PH V) | APPROVED | 350 |
| 6 82 8416 | FLEXIBLE MACHINING SYSTEM - RIA (CAM) | APPROVED | 138 |
| 6 84 8416 | FLEXIBLE MACHINING SYSTEM - RIA NCAM) | APPROVED | 399 |
| 6 85 8416 | FLEXIBLE MFG SYSTEM W/SPECIAL TOOLING - RIA | BUDGET | 178 |

## INTEGRATED MANUFACTURING SYSTEM PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 6 81 8154 | COMPUTER INTEGRATED MANUFACTURING (CIM),DDNC | APPROVED | 442 |
| 6 83 8154 | COMPUTER INTEGRATED MANUFACTURING (CIM) FOR CANNON | APPROVED | 650 |
| 6 84 8154 | COMPUTER INTEGRATED MANUFACTURING (CIM) FOR CANNONS | APPROVED | 450 |

| EFFORT NO | SUB TASK | SUBTASK TITLE |
|---|---|---|
| 6 | 7985 F | TRAVELING ELECTRODE ECM RIFLING |

PROBLEM AND SOLUTION

PROBLEM - MECHANICAL BROACHING IS THE MOST COMMONLY USED METHOD FOR RIFLING GAIN TWIST BARRELS. IT IS CHARACTERIZED BY POOR SURFACE SMOOTHNESS, EXCESSIVE TOOL WEAR, AND HIGH LABOR COST. STATIONARY ELECTRODE ELECTROCHEMICAL MACHINING (ECM) IS ANOTHER METHOD USED TO BROACH THE GAIN TWIST BARREL. IT IS CHARACTERIZED BY VARIBLE GROOVE DEPTH, VERY LARGE GROOVE RADII, AND EXCESSIVE ELECTRODE INTEGRITY PROBLEMS.
SOLUTION - UTILIZE A TRAVELING ELECTRODE ECM PROCESS FOR THE RIFLING OF GAIN TWIST BARRELS.

APPROACH

DESCRIPTION OF WORK - FY84 - THE CONTRACTOR SHALL DESIGN AN ECM RIFLING SYSTEM WITH THE FOLLOWING CAPABILITIES - CAPABILITY TO RIFLE 20MM TO 40MM, CAPABILITY TO RIFLE 5 BARRELS AT A TIME, MIXED 20MM THROUGN 40MM, NC DRIVE OF ELECTRODE(S), INTEGRATED SLUDGE FILTRATION SYSTEM.
FY85 - THE CONTRACTOR SHALL FABRICATE AND TEST THE PROTOTYPE DESIGN IN A PRODUCTION ENVIRONMENT.

EFFORT NO. 73D2
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 1 73D2 | PROD OF TIB2 COATED LONG LIFE TOOLS | 81 | D | CANCELLED |
| | | 83 | D | CANCELLED |
| | | 84 | 4DD | APPORTIONMENT |

PROBLEM AND SOLUTION

PROBLEM - AIRFRAME COMPONENTS AND PRINTED CIRCUIT BOARDS OF FIBERGLASS AND OTHER COMPOSITES SUCH AS GRAPHITE EPOXY ARE DIFFIC ULT TO MACHINE. CONVENTIONAL CUTTING TOOLS WEAR RAPIDLY WITH 5-10% OF THE LIFE EXPECTED WHEN COMPARED TO USE ON TITANIUM WOR KPIECES. THE QUALITY AND DIMENSIONAL ACCURACY OF HOLES FORMED WITH CONVENTIONAL TOOLS ARE CONTINUING MANUFACTURING PROBLEMS. TITANIUM DIBORIDE (TIB2) COATED TOOLS, WHICH CAN INCREASE THE LIFE OF CONVENTIONAL STEEL TOOLS BY UP TO A FACTOR OF 2 IN MI LLING OPERATIONS AND UP TO 8 IN FIBERGLASS DRILLING OPERATIONS, ARE NOT AVAILABLE AT AN ECONOMICAL COST.
SOLUTION - THE ABILITY TO MANUFACTURE TIB2 COATED TOOLS WILL BE SCALED UP FROM CURRENT LABORATORY-SIZED ELECTROLYTIC CELLS (1 5 LBS.) TO AN ECONOMICALLY FEASIBLE PRODUCTION SIZE (3DD LBS.) FACILITY CAPABLE OF ELECTROPLATING VARIOUS TOOL TYPES AND SHAP ES. EFFICACY OF THE PROCESS WILL BE DEMONSTRATED THROUGH EVALUATION OF THE MACHINING EFFICIENCY OF THE COATED TOOLS IN FIEL D TRIALS BY VARIOUS FABRICATORS OF FIBERGLASS PARTS.

APPROACH

DESCRIPTION OF WORK - DEVELOPING THE MANUFACTURING TECHNOLOGY FOR PRODUCING BORIDE COATED LONG-LIFE TOOLS FOR MACHINING FIBER GLASS COMPONENTS REQUIRES A ONE-YEAR EFFORT TO SCALE UP THE PROCESS AND AN ADDITIONAL SIX MONTHS TO CONDUCT FIELD T ESTS OF T HE COATED TOOLS AT VARIOUS FABRICATING PLANTS. IT WILL BE A COOPERATIVE EFFORT BTWEEN AMMRC, A COATING MANUFACTURER, AND FIB ERGLASS COMPONENT FABRICATORS, TO INCLUDE - DESIGN A SCALED-UP PROCESS AND EQUIPMENT - (C). PRODUCE SAMPLES OF COATED TOOLS BY SCALED-UP PROCESS - (C). CONSTRUCT A 1DD 1/4" DRILL DEMONSTRATION PILOT LINE - (C). EVALUATE COATING INTEGRITY - (A ? C) . PRODUCE TOOLS BY PILOT LINE PROCESS - (C). DEVELOP INSPECTION PROCEDURE - (C). DETERMINE COATED TOOL PERFORMANCE WITH FI BERGLASS WORKPIECES - (F). EVALUATE TOOL PERFORMANCE AND COST EFFECTIVENESS - (C). PROCESS SPECIFICATIONS AND COST ANALYSIS FOR VARIOUS TOOL SIZES AND CONFIGURATIONS - (C). FINAL PRODUCT TECHNICAL REPORT - (C). TRANSFER COATING MANUFACTURING TEC HNOLOGY TO CUTTING TOOL MANUFACTURERS - (C).
KEY - C=COATING MANUFACTURER, A=AMMRC, F=FIBERGLASS MACHINING FABRICATORS.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 1 8190 | IMPROVD CUTTER LIFE, T-70D COMP BLISK/IMPELLER MILLING OPER | 81 | 225 | COMPLETED |
| | | 82 | 486 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - THE EXPENSE OF PURCHASING AND SHARPENING END MILL CUTTERS FOR MACHINING T70D TURBINE ENGINE BLISK AND IMPELLER AIRFOILS IS APPROXIMATELY $3400 PER ENGINE. IN ADDITION, THE COST OF CHANGING CUTTERS IS APPROXIMATELY $370 PER ENGINE. BOTH AT SELL PRICE. THIS RESULTS IN AN EXPENDITURE OF APPROXIMATELY $3770 PER ENGINE.
SOLUTION - INVESTIGATE CUTTER PARAMETERS AND EVALUATE VARIOUS GRIND GEOMETRIES TO OBTAIN MAXIMUM MILLING CUTTER LIFE. CUTTER GRINDING WILL BE DONE ON A HOFFMAN 8 AXIS CUTTER GRINDER AND SUBSEQUENTLY EVALUATED UNDER PRODUCTION CONDITIONS. REDUCE CUTTER COSTS BY 50 PERCENT OR APPROXIMATELY $1885 PER ENGINE.

APPROACH

DESCRIPTION OF WORK - FY81 - THE CLEAREST OPPORTUNITIES FOR REDUCING CUTTER USAGE WILL BE INVESTIGATED, I.E., FINISH CUTTER LAND WIDTH, ROUGH AND FINISH CUTTER WEAR ALLOWANCE, ROUGH AND FINISH CUTTER STIFFNESS, ROUGH AND FINISH CUTTER MATERIAL, CUTTER SPEED AND CHIP THICKNESS. CONSULTANTS WILL BE USED, INCLUDING CUTTER MANUFACTURERS. THEIR SUGGENSTIONS WILL BE SOUGHT CONCERNING FACTORS TO BE INVESTIGATED, AND THE DESIGN OF TESTS. KEY ITEMS TO BE CONSIDERED WILL BE - CUTTER RAKE ANGLE, NUMBER OF CUTTING EDGES, CUTTING FLUID, DEPTH OF CUT AND WIDTH OF CUT.
FY81/82 - INVESTIGATIONS WILL BE BASED PRIMARILY UPON TESTS WITH SUBSTANTIAL NUMBERS OF CUTTERS HAVING EACH OF THE VARIOUS CHARACTERISTICS TO BE STUDIED. TESTS WILL BE MADE WITH SUITABLE TOOL ROOM, VENDOR, OR PRODUCTION MILLING MACHINES AND WITH PRODUCTION 5A/4S MACHINES. FINAL EVALUATION WILL BE RUN ON A PRODUCTION MACHINE. NC PROGRAMMING WILL BE PREPARED, AS NEEDED, TO MAKE TESTS WITH LARGER DIAMETER, STIFFER CUTTERS- WITH INCREASED FINISH CUTTER WEAR ALLOWANCE WITHOUT INCREASED AIRFOIL THICKNESS AND WITH DIFFERENT CUT DIMENSIONS. TEST WILL INCLUDE CUTTER INSPECTION BEFORE USE, MONITORING OF WEAR AND LIFE DURING USE, INSPECTION OF CUTTERS AFTER USE AND MONITORING MACHINED SURFACE INTEGRITY AND MACHINED DIMENSIONS PRODUCED DURINGTESTS.

EFFORT NO. 8248
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 8248 | APPLICATION OF HIGH-RATE CUTTING TOOLS | 82 | 102 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - APPLICATIONS OF NEW HIGH-RATE CUTTING TOOLS LAG DUE TO LACK OF TESTING, ANALYSES AND ENGINEERING EVALUATIONS. BOTH CUTTING TOOL AND MACHINE TOOL MANUFACTURERS PROVIDE INSUFFICIENT DATA FOR EFFICIENT APPLICATIONS OF NEW TOOL GEOMETRIES AND MATERIALS, PARTICULARLY ON OLDER, EXISTING MACHINE TOOLS.

SOLUTION - THIS ONE-YEAR EFFORT WILL TEST, ANALYZE, EVALUATE AND APPLY NEW HIGH-RATE CUTTING TOOLS WITH BOTH NEW AND EXISTING MACHINE TOOLS, AND WILL PROVIDE METHODS TO ADAPT SUCH TOOLING ON OLD AND NEW MACHINES.

APPROACH

DESCRIPTION OF WORK - NEW TOOL MATERIALS WILL BE TESTED IN TURNING, MILLING AND DRILLING OPERATIONS WITH EMPHASIS ON CERAMIC AND SIMILAR OXIDE-TYPE TOOL MATERIALS FOR HIGH-RATE TURNING. VARIOUS MAKES, GRADES AND GEOMETRIES WILL BE EVALUATED IN BOTH STRAIGHT AND INTERMITTENT CUTTING. TOOL WEAR AND BREAKAGE WILL BE EVALUATED WITH RESPECT TO SHOCK AND VIBRATION WITH NEW AND OLD MACHINE TOOLS. THE TEST RESULTS WILL BE ANALYZED AND THE MATERIALS WILL BE EVALUATED FOR BOTH MACHINING RATE AND COST B ENEFITS. LIMITS FOR APPLICATIONS IN MILLING, DRILLING AND GRINDING WILL ALSO BE ESTABLISHED; AND, WITH EMPHASIS ON IMPROVEIN G TURNING WITH NATURAL AND MAN-MADE DIAMONDS. A TECHNICAL REPORT WILL BE WRITTEN WITH ENGINEERING GUIDELINES FOR IMPROVING APPLICATIONS OF THE NEW MATERIALS, WITH RESPECT TO WORK MATERIALS AND MACHINE TOOLS, AND FOR ANALYZING CONTINUOUS FEEDBACK OF RESULTS AND EXTENDING APPLICATIONS. BASIC TESTS AND ANALYSES WILL BE CONDUCTED BY CONTRACTED SERVICES IN CONJUNCTION WITH S IMULTANEOUS IN-HOUSE TESTS, ANALYSES AND EVALUATIONS FOR IMMEDIATE IMPLEMENTATION DURING THE PROJECT. ALL WORK WILL BE COORD INATED WITH ROCK ISLAND ARSENAL METHODS ? STANDARDS TOOL ENGINEERS.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 8439 | IMPROVED RIFLING PROCEDURES | 84 | 80 | APPORTIONMENT |

PROBLEM AND SOLUTION

PROBLEM - RIFLING GROOVES ARE MACHINED IN GUN TUBES BY MOUNTING A SERIES OF BROACH CUTTERS ONTO A HEAD OR HOLDER, ONE AT A TIME AND PUSHING THEM THROUGH THE BORE WHICH IS QUITE TIME CONSUMING AND UNCHANGED FOR 25 YEARS. TOO MUCH WEAR CAUSES THE HEAD TO FLOAT SOMETIMES CAUSING CHATTER AND ALSO RESULTING IN VARIATIONS OF GROOVE DEPTH. THE HEAD MUST THEN BE REMOVED AND RECONDITIONED. THE BROACH CUTTERS ARE RE-SHARPENED AT A FREQUENCY THAT AFFECTS THE BROACH LIFE, AND SUBSEQUENTLY SCRAPPED WHEN REDUCED TO A CERTAIN THICKNESS.
SOLUTION - INTRODUCE A NEW CONCEPT IN BROACH HEAD MANUFACTURE TO ELIMINATE WEAR AND PROBLEMS RELATED TO WORN HEADS SUCH AS VARIATIONS IN GROOVE DEPTH, CHATTER AND TOOL LIFE. ASSURE STABILITY IN THE CUTTING ACTION, AND ADDRESS INCREASE IN CUTTING SPEED AND IN CHIP LOAD, RESULTING IN THE USE OF LESS BROACH CUTTERS PER OPERATION.

APPROACH

DESCRIPTION OF WORK - INTRODUCE A NEW DESIGN FOR RIFLING HEADS TO ELIMINATE THE NEED FOR THE PRESENT RECONDITIONING PROCESS. THIS RIFLING HEAD WOULD ALSO IMPROVE THE STABILITY OF THE PROCESS THUS ASSURING A BETTER PRODUCT AND ALLOWING THE INTRODUCTION OF NEW INNOVATIONS WITH RESPECT TO BROACH CUTTER MATERIAL AND SURFACE TREATMENT OF THE CUTTING EDGES.
INITIAL TESTING WILL BE DONE ON THE 105MM M68 GUN.
MANUFACTURE SIMILAR EQUIPMENT FOR THE LARGER 155MM AND 8 IN. CANNON TUBES

EFFORT NO. 5082
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 4 5082 | FLEXIBLE MACHINING SYSTEM PILOT LINE FOR TCV COMPONENT | 79 | 904 | COMPLETED |
| | | 80 | 857 | COMPLETED |
| | | 81 | 779 | APPROVED |
| | | 82 | 750 | APPROVED |
| | | 83 | 350 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - ITEMS MANUFACTURED IN LARGE NUMBERS USING MASS PRODUCTION TECHNOLOGY (AUTOMATION) COST LESS PER ITEM THAN THE SAME ITEM PRODUCED IN SMALL QUANTITIES. PARTS FOR TRACKED COMBAT VEHICLES ARE RARELY PROCURED IN QUANTITIES WHICH PERMIT THE BENEFITS OF MASS PRODUCTION TO BE REALIZED. THUS, TCV PARTS ARE EXTREMELY EXPENSIVE TO PRODUCE.

SOLUTION - THE ADVANTAGES OF MASS PRODUCTION CAN BE BROUGHT TO THE PRODUCTION OF ITEMS PROCURED IN MEDIUM SIZE QUANTITIES (1,000 TO 100,000 PARTS) BY A CONCEPT KNOWN AS A 'FLEXIBLE MACHINING SYSTEM'. THIS CONCEPT, EMPLOYING COMPUTERS AND COUPLED WITH SIMPLIFIED MASS PRODUCTION TYPE TOOLING CAN INTRODUCE A LEVEL OF FLEXIBILITY WHICH WILL ENABLE IT TO HANDLE A NUMBER OF SUITABLY SELECTED SIMILAR PARTS WITH VERY NEARLY THE SAME EFFICIENCY AS IS ACHIEVED IN MASS PRODUCTION. THE PHASE I EFFORT (FY79) IS BEING COORDINATED WITH THE CONTRACTOR WHO HAS A PROTOTYPE FMS SYSTEM. THIS FMS SYSTEM WAS OBSERVED TO DETERMINE EFFICIENCY, PROBLEMS IN SOFTWARE PROGRAMMING AND OPPORTUNITIES FOR SYSTEM OPTIMIZATION. THE PHASE II EFFORT (FY80) WILL CONTINUE SOFTWARE OPTIMIZATION AND PRODUCE GENERIC SPECIFICATIONS OF SOFTWARE AND HARDWARE. PHASE III WILL CONCLUDE THE PHASE II EFFORT AND EXAMINE ADAPTIVE CONTROL SYSTEMS TO ENHANCE FMS PERFORMANCE. A FINAL REPORT WILL BE WRITTEN.

APPROACH

DESCRIPTION OF WORK - THE PROGRAM IS BEING CONDUCTED IN THREE PHASES WHICH WILL IN A SERIES OF ITERATIONS EVOLVE A GENERIC GUIDE FOR THE SELECTION AND APPLICATION OF FMS TECHNOLOGY. ALONG WITH THE GUIDE, SOFTWARE WILL BE PRODUCED WHICH WILL ANALYZE THE PARTS TO BE MANUFACTURED, CONFIGURE AN FMS SYSTEM FOR THE PARTS, AND PROVIDE SOFTWARE TO ESTABLISH THE OPERATIONAL POLICIES. PHASE I PROVIDED COORDINATION OF EFFORTS BY USERS AND SUPPLIERS TO IDENTIFY NEEDS AND CAPABILITIES. PRELIMINARY IMPROVEMENTS IN EXISTING SOFTWARE WERE MADE AND THE GENERAL REQUIREMENTS OUTLINED. PHASE II WILL CONTINUE THE SOFTWARE IMPROVEMENT, REFINED SELECTION CRITERIA AND PROVIDED THE INITIAL DRAFT OF A GENERIC SPECIFICATION AND/OR GUIDE. PHASE III WILL PROVIDE A COMPLETE GENERIC GUIDE AND SPECIFICATION PLUS SOFTWARE THAT HAS BEEN VERIFIED WITH EXISTING SYSTEMS. A COMPLETE COST ANALYSIS WILL ALSO BE PROVIDED.

| | EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|---|
| * 6 | 8416 | FLEXIBLE MACHINING SYSTEM-RIA (CAM) | 82 | 138 | APPROVED |
| * | | | 84 | 399 | APPORTIONMENT |
| * | | | 85 | 178 | BUDGET |

PROBLEM AND SOLUTION

PROBLEM - EXISTING REQUIREMENTS FOR X-RAY ON THE WELDMENTS AND CASTINGS OF HOWITZER CARRIAGES INVOLVES SUCH A MULTITIDE OF POSITIONS AND EXPOSURES AT VARIOUS STAGES OF ASSEMBLY THAT IT HAS BEEN IMPOSSIBLE WITH THE MANUAL SYSTEM TO MAINTAIN ADEQUATE CONSISTENCY AND PRECISION. THERE A LACK OF APPARATUS FOR ACHIEVING A DESIRED POSITION WHEN SPECIFIED, AND NO MEANS FOR ACCURATELY DETERMINING, RECORDING, AND TRANSMITTING SUCH INFORMATION WHEN THE SPECIFICATIONS ARE BEING DEVELOPED.

APPROACH

DESCRIPTION OF WORK - (1) DEVELOP INITIAL FMS CONFIGURATIONS USING COMPUTERIZED PART/MACHINE SELECTION ALGORITMS DEVELOPED BY CHARLES STARK DRAPER LABORATORY, INC. (CSDL) UNDER CONTRACTS FROM THE US ARMY TANK-AUTUMOTIVE COMMAND (TACOM). DEVELOP FMS COMPATIBLE PROCESS PLANS FOR SELECTED PARTS INCORPORATING AS MUCH AS POSSIBLE IMPROVED MACHINING TECHNIQUES.ESTIMATE FIXTURING TIMES AND SELECT DESIRED INSPECTION TECHNIQUES. SYSTEM BEING INSPECTED WHILE PROVIDING ACCURATE CONTROL OF THE X-RAY EXPOSURE. A SELF TEACHING CAPABILITY WILL BE PROVIDED, WHICH WILL PERMIT A RADIOGRAPHER TO PROGRAM THE SYSTEM SIMPLY BY PLACING THE SOURCE, FILM, OR SPECIMEN IN THE PROPER POSITION,FOLLOWED BY PRESSING ONE OR TWO KEYS ON THE KEYBOARD TO COMMAND THE SYSTEM TO MEMORIZE THE POSITION, SEQUENCE, SERIAL NUMBER, AND OTHER DATA FOR THAT EXPOSURE.PROVIDE MOCK-UP HOWITZER CARRIAGE SUB-ASSEMBLIES AS TEST SPECIMENS AND A DESIGN FOR A COMPLETE TEST.

EFFORT NO. 8154
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 8154 | COMPUTER INTEGRATION MFG (CIM), DDNC | 81 | 442 | APPROVED |
| | | 83 | 650 | APPROVED |
| | | 84 | 450 | APPORTIONMENT |

PROBLEM AND SOLUTION

PROBLEM - CONVENTIONAL NUMERICAL CONTROL (NC) MANUFACTURING PRACTICES UTILIZING PUNCHED TAPE AS PRIMARY INPUT MEDIA SEVERELY RESTRICT PRODUCTIVITY OF NC FACILITIES, GENERATE UNNECESSARY LEVELS OF LABOR INTENSIVE SUPPORT FUNCTIONS AND STIFLE OPPORTUNITIES TO EXPLOIT CAD/CAM TECHNOLOGIES ON A CONTINUING BASIS FOR CANNON MANUFACTURE.

SOLUTION - INTERFACE IN-HOUSE COMPUTER FACILITIES WITH CURRENT AND FUTURE NC MACHINE TOOLS TO FORM AN ADVANCED COMPUTER INTEGRATED MANUFACTURING (CIM) SYSTEM FOR CANNONS, OPERATING UNDER A DISTRIBUTED NUMERICAL CONTROL (DNC) SYSTEM TO FUNCTION EXCLUSIVELY ON COMPUTER GENERATION, VERIFICATION AND AUTOMATIC TRANSMISSION OF NC DATA TO MACHINE TOOLS. THE SYSTEM WILL BE ENGINEERED TO CAUSE TOTAL ELIMINATION OF PUNCHED TAPE FROM THE SHOP FLOOR, AND ALLOW INTEGRATION OF CAD/CAM TECHNOLOGIES IN CANNON MANUFACTURE, E.G., ON-LINE MAINTENANCE DIAGNOSTICS, ADAPTIVELY CONTROLLED MACHINING, USE OF INTERACTIVE GRAPHICS FOR INSPECTION AND PART PROGRAM VERIFICATION, AND REAL TIME MANAGEMENT INFORMATION FEED BACK.

APPROACH

DESCRIPTION OF WORK - FY81 - AN ANALYSIS WILL BE CONDUCTED TO ESTABLISH WHERE SIGNIFICANT CIM COST SAVING OPPORTUNITIES EXIST IN THE CANNON MANUFACTURING PROCESSES. FROM THIS COMPREHENSIVE ANALYSIS, SYSTEMS ENGINEERING AND DESIGN WORK WILL PROVIDE THE SPECIFICATIONS AND JUSTIFICATION FOR AR 18-1 DOCUMENTATION TO SEEK THE REQUIRED APPROVALS THROUGH DARCOM ADP CHANNELS FOR THE PURCHASE OF PILOT DNC SYSTEM PERIPHERAL HARDWARE AND SOFTWARE.

THE SPECIFICATIONS AND JUSTIFICATION FOR THE PILOT DNC SYSTEM WILL INCLUDE - DESCRIPTION OF SYSTEMS HARDWARE REQUIREMENTS, DESCRIPTION OF SOFTWARE TO INCLUDE SPECIAL SYSTEMS SOFTWARE NEEDS, SYSTEMS INFORMATION DESCRIBING IN-HOUSE CAM/NC FACILITIES INTEGRATION AND APPLICATION, COST FACTORS FOR THE PURCHASE OF HARDWARE, SOFTWARE AND SYSTEMS DESIGN AND INTEGRATION, COST AND BENEFITS ANALYSIS OF THE PILOT DNC SYSTEM.

DEVELOP TO DESIGN SPECIFICATIONS AND PURCHASE HARDWARE AND SOFTWARE FOR THE PROTOTYPE DNC SYSTEM. INSTALL AND ITERFACE PURCHASED HARDWARE/SOFTWARE WITH IN-HOUSE NC/CAM FACILITIES TO FORM A PILOT DNC SYSTEM. TEST AND DEBUG SYSTEM.

FY83-UTILIZE THE PILOT DNC SYSTEM AS PROTOTYPE TEST BED FOR SYSTEMS DESIGN, HARDWARE SELECTION AND SOFTWARE ENGINEERING TO INTEGRATE ADVANCED CAD/CAM TECHNOLOGIES. SYSTEMS DEALING WITH ON-LINE MACHINE DIAGNOSTICS, ADAPTIVE MACHINE CONTROL, MANAGEMENT INFORMATION FEED BACK AND COMPUTER GRAPHICS WILL BE TESTED AND EVALUATED. TECHNICAL ANALYSIS WILL BE CONDUCTED AND A TECHNICAL REPORT PREPARED OF THE CIM FOR CANNON SYSTEM DEVELOPED BY WATERVLIET ARSENAL.

## ROBOTICS PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 6 80 7928 | ROBOTIZED BENCHING OPERATIONS (CAM) | COMPLETED | 113 |
| 6 81 7928 | ROBOTIZED BENCHING OPERATIONS (CAM) | APPROVED | 287 |

## MACHINABILITY DATA PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| T 79 5090 | IMPROVED AND COST EFFECTIVE MACHINING TECHNOLOGY | COMPLETED | 455 |
| T 80 5090 | IMPROVED AND COST EFFECTIVE MACHINING TECHNOLOGY (PHASE II) | COMPLETED | 229 |
| T 81 5090 | IMPROVED AND COST EFFECTIVE MACHINING TECHNOLOGY (PHASE III) | COMPLETED | 30 |
| T 82 5090 | IMPROVED AND COST EFFECTIVE MACHINING TECHNOLOGY (PHASE IV) | APPROVED | 250 |
| 4 83 5090 | IMPROVED AND COST EFFECTIVE MACHINING TECHNOLOGY (PHASE V) | APPROVED | 123 |
| 4 84 5090 | IMPROVED AND COST EFFECTIVE MACHINING TECHNOLOGY (PHASE V) | APPORTIONMENT | 275 |
| 6 77 7707 | AUTOMATED PROCESS CONTROL FOR MACHINING (CAM) | COMPLETED | 105 |
| 6 79 7707 | AUTOMATED PROCESS CONTROL FOR MACHINING-CAM | UNFUNDED | 95 |
| 6 80 7707 | AUTOMATED PROCESS CONTROL FOR MACHINING (CAM) | UNFUNDED | 114 |
| 6 82 7707 | AUTOMATED PROCESS CONTROL FOR MACHINING | APPROVED | 135 |

## ESTABLISH MACHINE TOOL PERFORMANCE SPECIFICATIONS PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 6 78 7802 | ESTABLISH MACHINE TOOL PERFORMANCE SPECIFICATIONS | COMPLETED | 195 |
| 6 79 7802 | ESTABLISH MACHINE TOOL PERFORMANCE SPECIFICATIONS | APPROVED | 288 |
| 6 80 8051 | APPLICATION AND CONTROL OF MACHINE TOOLS (CAM) | APPROVED | 209 |
| 6 81 8051 | APPLICATION AND CONTROL OF MACHINE TOOLS | CANCELLED | 0 |

EFFORT NO. 7928
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 7928 | ROBOTIZED BENCHING OPERATIONS (CAM) | 80 | 113 | COMPLETED |
| | | 81 | 287 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - PAST INVESTIGATIONS PERTAINING TO BENCHING OPERATIONS ON BREECHBLOCKS AND RINGS HAVE SHOWN THAT CURRENT METHODS ARE UNSAFE FOR THE OPERATOR AND EXCESSIVELY TIME CONSUMING. THE OPERATION TAKES APPROXIMATELY 4 HOURS DEPENDING UPON WEAPON AND COMPONENT WITH A CONSIDERABLE AMOUNT OF TIME SPENT GRINDING RADII ON THE ENDS OF INTERNAL SEGMENTED THREADS. THE OPERATOR USES A HIGH SPEED AIR DRIVEN TOOL WHICH CAUSES A CONSIDERABLE AMOUNT OF AIR TURBULENCE. DUE TO THE GEOMETRY OF THE COMPONENT, VISIBILITY IS POOR. THESE TWO FACTORS COMBINED ARE THEN A MAJOR CAUSE OF EYE INJURIES.
SOLUTION - IN ROBOTIZING BENCHING OPERATIONS, BREECH RINGS AND BREECHBLOCKS IN PARTICULAR, AN INDUSTRIAL ROBOT WILL BE USED IN MANUFACTURING OPERATIONS THAT ARE TOO HAZARDOUS, TOO BORING OR TOO UNECONOMICAL FOR HUMANS. THUS, WITH A ROBOT IN CONTROL, THE HAZARDOUS ASPECT OF BENCHING OPERATIONS WILL BE ELIMINATED AND METAL GRINDING TIME WILL BE REDUCED TO 50 PERCENT OR LESS.

APPROACH

DESCRIPTION OF WORK - THE EFFORT WILL DRAW UPON EXPERIENCE GAINED WITHIN THE GOVERNMENT AS WELL AS IN PRIVATE INDUSTRY. THE FIRST YEAR EFFORT OF PRE-ENGINEERING ASSOCIATED WITH MANUFACTURING APPLICATIONS WILL DETERMINE THE TYPE OF EQUIPMENT NECESSARY AT WATERVLIET ARSENAL. SPECIFICALLY, WE ARE LOOKING AT PROGRAMMABLE ROBOTS AND NOT DEDICATED EQUIPMENT SO THAT A VARIETY OF TASKS MAY BE PERFORMED. BASED UPON THESE FINDINGS, SPECIFICATIONS WILL BE DRAWN UP ACCORDINGLY. DETAILED IN-HOUSE AND OUT-OF-HOUSE STUDIES WILL BE PERFORMED TO AID IN PROCESS OF APPLICATION AND EQUIPMENT SELECTION. SUBSEQUENTLY, MATERIAL ACQUISITION AND INSTALLATION WILL BE IMPLEMENTED.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 4 5090 | IMPROVED AND CUST EFFECTIVE MACHINING TECHNOLOGY | 79 | 455 | COMPLETED |
| | | 80 | 229 | COMPLETED |
| | | 81 | 3D | COMPLETED |
| | | 82 | 25D | APPROVED |
| | | 83 | 123 | APPROVED |
| | | 84 | 275 | APPORTIONMENT |

PROBLEM AND SOLUTION

PROBLEM - MANY TRACKED COMBAT VEHICLE (TCV) COMPONENTS ARE SUBJECT TU HIGH RECURRING COSTS AND LONG LEAD TIMES. THIS IS TYPICALLY THE RESULT OF POOR MANUFACTURING SYSTEM PERFORMANCE WHEN THE CHOICE OF MACHINING TECHNOLOGY IS MADE WITHOUT THE BENEFIT OF SPECIFIC MACHINING DATA. THE LACK OF DATA LEADS TO THE SELECTION OF COSTLY TOOLING AND INEFFICIENT METAL REMOVAL.
SOLUTION - ESTABLISH IMPROVED AND CUST EFFECTIVE COMBINATIONS OF CUTTING TUOLS, CUTTING FLUIDS AND MACHINING CONDITIONS SUCH AS SPEED, FEED, AND DEPTH OF CUT FOR EACH OF THE IMPORTANT MACHINING OPERATIONS AND GRADES OF MATERIAL EMPLOYED IN TCV PARTS. PHASE I (FY79) IS ESTABLISHING COST-EFFECTIVE MEANS FOR END AND FACE MILLING, DRILLING, REAMING, AND TAPPING TCV PARTS. PHASE II (FY80) WILL ESTABLISH MEANS FOR ROUGH AND FINISH TURNING FACING, AND BORING THESE PARTS. PHASE III (FY81) WILL ESTABLISH MEANS FOR GRINDING, GEAR CUTTING AND BROACHING.

APPROACH

DESCRIPTION OF WORK - EXTENSIVE SERIES OF MACHINING TESTS ON SEVERAL IMPORTANT TCV WORK MATERIALS AND MACHINING OPERATIONS. THE CUST-EFFECTIVE MACHINING TECHNOLOGY IS ESTABLISHED THROUGH ECONOMIC ANALYSIS OF THE MACHINING OPERATIONS BASED ON DATA OBTAINED THROUGH THE MACHINING TESTS ON IMPORTANT TCV WORK MATERIALS. THE COST-EFFECTIVE MACHINING TECHNOLOGY WILL BE MADE AVAILABLE TU PRIME AND SUBCONTRACTORS OF TCV SYSTEMS THROUGH TECHNICAL REPORTS, A MACHINABILITY DATA HANDBOOK, TECHNICAL BRIEFINGS, AND DEMONSTRATIONS. THE PROPOSED WORK IS DIVIDED INTO THREE PHASES, EACH CONSISTING OF EXTENSIVE SERIES OF MACHINING TESTS. CONCURRENTLY WITH THE THREE PHASES, A MACHINABILITY DATA HANDBOOK, SPECIALLY DESIGNED FOR PRIME AND SUBCUNTRACTORS OF TCV PARTS, WILL BE PREPARED. THE TOTAL PROGRAM DURATION IS 36 MONTHS. EACH OF THE PHASES IS DESIGNED TU DEVELOP COST-EFFECTIVE MACHINING TECHNOLOGY ON SPECIFIC GROUPS OF MACHINING OPERATIONS ON WORK MATERIALS APPLICABLE TO TCV PARTS. THIS APPROACH SHOULD PROVIDE DIRECTLY IMPLEMENTABLE MACHINING TECHNOLOGY AFTER EACH PHASE.

EFFORT NO. 7707
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 7707 | AUTOMATED PROCESS CONTROL FOR MACHINING (CAM) | 77 | 105 | COMPLETED |
| | | 82 | 135 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - PRESENT CONTROL IN SELECTION AND APPLICATION OF MACHINING PARAMETERS AND OPERATIONS IS LIMITED, AND COST ESTIMATION OF MACHINING IS SLOW AND INACCURATE. SIMILARLY, CONTROL OF MACHINING PARAMETERS FROM, AND THROUGH, PROTOTYPE, PLANNING, PILOT AND MASS PRODUCTION MACHINING IS LIMITED. NEW CONTROLS ARE REQUIRED TO REDUCE TIME COSTS.

SOLUTION - THIS IS THE SECOND OF A TWO-YEAR PROGRAM FOLLOWING COMPUTERIZATION OF A MACHINING PARAMETERS SELECTION, COMPARISON AND COST ESTIMATION SUB-SYSTEM IN THE FIRST-YEAR EFFORT. THE SUB-SYSTEMS COMPUTER PROGRAMS WILL BE WRITTEN COMPLETE WITH STORAGE MATRICES OF OPERATIONS/PARAMETERS, COST AND TIME. THE SUB-SYSTEM MATRICES WILL BE INTEGRATED- AND THE TOTAL SYSTEM WILL BE TESTED AND IMPLEMENTED AT ROCK ISLAND ARSENAL WITH CONTINUOUS FEEDBACK BETWEEN PLANNING, COST ESTIMATING, SCHEDULING AND MACHINING OPERATIONS.

APPROACH

DESCRIPTION OF WORK - DURING FY77, THE COMPUTERIZED SELECTION OF MACHINING PARAMETERS FOR TURNING WITH TIME COMPARISONS AND COST ESTIMATION SUBSYSTEMS WAS COMPLETED IN CONTRACT WORK WITH THE UNIVERSITY OF MICHIGAN. TURNING AND 414D ALLOY WERE USED AS THE BASIC OPERATION AND MATERIAL TO ESTABLISH COMPUTERIZED SETTING OF THE MACHINING PARAMETERS AT THE ROCK ISLAND ARSENAL NC PROGRAMMING LEVELS- AND, MANUAL ADAPTIVE CONTROL TECHNIQUES WERE USED WITH HAND COMPUTERS TO MAKE TIME AND COST COMPARISONS WITH SHOP FLOOR FEEDBACK. IN THIS SECOND YEAR, THE MATRIX-FORM SUBSYSTEMS DESIGNED IN THE FIRST YEAR FOR OPERATION VS. WORK PIECE VS. TOLERANCES VS. TIME VS. COST, WILL BE INTEGRATED WITH AN IN-HOUSE-DEVELOPED COMPUTERIZED DATA BASE TO PROVIDE A MASTER MATRIX FOR AUTOMATED PROCESS SELECTION. THE MASTER MATRIX AND BASIC FORMULAS WILL BE ESTABLISHED COOPERATIVELY WITH THE CONTRACTOR FOR SELECTING AND APPLYING CUTTING PARAMETERS WITHIN EACH PROCESS. THE MATRIX WLL BE TESTED, WITH SHOP FLOOR OPTIMIZATION AND FEEDBACK, THROUGH PLANNING, PROGRAMMING AND PRODUCTION FOR CONTROLLING ACCURACY, RATE AND COST IN MACHINING. FORMATS WILL BE COMPLETED FOR PRODUCTION DATA FEEDBACK, AND FOR CONTINUOUSLY IMPROVING THE DATA BASE AND MATRICES. A TECHNICAL REPORT WILL BE WRITTEN AND WILL INCLUDE THE MATRIX AND DATA FORMATS, THE FORMULAS AND COMPUTER PROGRAMS, AND ENGINEERING GUIDELINES. ALL MANUFACTURING PERSONNEL WITH RELATED WORK WILL BE TRAINED FOR USE OF THE CAM SYSTEM.

EFFORT NO. 7802
83/12/09.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 7802 | ESTABLISH MACHINE TOOL PERFORMANCE SPECIFICATIONS | 78 | 195 | COMPLETED |
| | | 79 | 288 | APPROVED |

PROBLEM AND SOLUTION

PROBLEM - PROCUREMENT, AQUISITION, AND APPLICATION OF NEW AND USED MACHINE TOOLS ARE BOTH PHYSICALLY AND ECONOMICALLY INEFFICIENT DUE TO THE LACK OF MEANINGFUL TEST PROCEDURES AND TESTING. NO GOVERNMENT OR NON-PROPRIETARY, PRIVATE INDUSTRY STANDARDS EXIST FOR ACCURATELY TESTING BOTH PHYSICAL AND ECONOMIC PRODUCTIVITY OF MACHINE TOOLS. CONSEQUENTLY, THE COSTS OF MACHINE TOOLS AND MANUFACTURE OF WEAPONS ARE HIGHER THAN NECESSARY.

SOLUTION - DEFINE MACHINING EFFICIENCY IN TERMS OF METAL REMOVAL RATE AND COSTS AND COORDINATE WITH CONTRACT WORK FOR INSTRUMENTATION, TESTS, AND ANALYSES TO DEFINE EFFICIENCY IN TERMS OF ACCURACY. APPLY THE TESTS AND PROCEDURES FOR SPECIFYING AND ANALYZING PERFORMANCE ACCORDING TO COMBINATIONS OF ACCURACY, METAL REMOVAL RATE, AND COSTS AT ROCK ISLAND ARSENAL.

EFFORT NO. 8051
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 8051 | APPLICATION AND CONTROL OF MACHINE TOOLS | 80 | 209 | APPROVED |
| | | 81 | 0 | CANCELLED |

PROBLEM AND SOLOTION

PROBLEM - CORRENT PROCEDURES FOR JOSTIFICATION, SELECTION, APPLICATION AND MAINTENANCE OF MACHINE TOOLS ARE INADEQOATE TO AVO ID PROCUREMENT OF INEFFICIENT, UNRELIABLE MACHINE TOOLS AND TO PERMIT PROCUREMENT AND APPLICATION OF MACHINE TOOLS HAVING SPE CIAL CAPABILITIES AND PROVEN RELIABILITY. CONSEQUENTLY, INFERIOR MACHINE TOOLS ARE FREQUENTLY PROCURED AND APPLIED WITHOUT B ENEFIT OF REDUCED MACHINING TIMES AND COSTS.

SOLOTION - THIS IS A 2-YEAR PROGRAM. DORING THE FIRST YEAR, ACCURATE DEFINITION OF MACHINE TOOLS REQUIREMENTS WILL BE ESTABL ISHED TO EFFICIENTLY MATCH WEAPON COMPONENT MACHINING REQUIREMENTS. PERFORMANCE ANALYSES AND COMPETITIVE PERFORMANCE EVALUAT IONS WILL BE DEVELOPED. RELIABILITY EVALOATIONS BY ANALYSES OF DESIGNS, TESTING AND FEEDBACK OF PRODUCTION/MAINTENANCE DATA, WILL BE STARTED. IN THE SECOND-YEAR, THE IMPROVED JOSTIFICATION, SELECTION AND RELIABILITY CONTROL METHODS WILL BE INTEGRAT ED AND IMPLEMENTED AT ROCK ISLAND ARSENAL.

APPROACH

DESCRIPTION OF WORK - IN THIS SECOND-YEAR EFFORT, THE ANALYTICAL METHODS FOR MACHINE TOOL SELECTION AND RELIABILITY CONTROL W ILL BE COMPLETED, COMPOTERIZED AND TESTED IN ASSIGNMENT OF AN EXISTING MACHINE TOOL THROOGH PROOOCTION SCHEDULING AND LOADING . ALL METHODS AND PROGRAMS DEVELOPED FOR IMPROVED MACHINE TOOL JOSTIFICATION, SELECTION, PERFORMANCE TESTING, AND RELIABILIT Y ANALYSES AND MAINTENANCE WILL BE INTEGRATED, TESTED FOR MACHINE TOOL PROCUREMENT, AND FOR PROOOCTION LOADING. ALSO, IN THE SELECTION AND APPLICATION OF MACHINE TOOLS FOR PROOOCTION, NEW POST-PROCESSOR COMPOTER PROGRAMS WILL BE APPLIED TO MATCH MAC HINES AND COMPONENT PARTS AND FAMILIES OF PARTS, ESTABLISHED BY DETAILED GROUP TECHNOLOGY, FOR MOST ECONOMICAL AND ACCURATE P RODOCTION CYCLING. ALL COMPOTER PROGRAMS WILL BE ADDED TO THE KIA CAM DATA BASE, AND THE MACHINE TOOL ANALYSES AND MAINTENAN CE DATA WILL BE OSED TO ESTABLISH THE RELIABILITY DATA BASE FOR CONTINUING USE IN LOADING EXISTING MACHINE TOOLS, AND SPECIFI CATION AND SELECTION OF NEW MACHINE TOOLS.

# APPENDIX G-3

# PLANNED PROJECTS

## IMPROVED METAL REMOVAL RATE PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 4 85 6095-05 | SKIVE HOBBING OF GEARS | BUDGET | 150 |

## ABRASIVE METAL REMOVAL PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 4 85 4009 | IMPROVED TRACK PIN GRINDING | BUDGET | 150 |
| 5 83 4380 | ABRASIVE MACHINING IN PROJECTILE MANUFACTURE | UNFUNDED | 176 |
| 5 84 4380 | ABRASIVE MACHINING IN PROJECTILE MANUFACTURE | BUDGET | 412 |
| 5 85 4380 | ABRASIVE MACHINING IN PROJECTILE MANUFACTURE | BUDGET | 192 |

## THERMAL ASSISTED MACHINING PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 4 84 6057-11 | THERMAL ASSISTED MACHINING | APPORTIONMENT | 325 |
| 4 85 6057-11 | THERMAL ASSISTED MACHINING | BUDGET | 325 |

## CREEP FEED CRUSH-FORM GRINDING PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 6 85 8543 | SLIDE TABLE CLIMB CREEP FEED GRINDING | BUDGET | 78 |

## IMPROVEMENT OF CURRENT PROCESS TECHNOLOGY PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 4 85 4013 | IMPROVED MACHINING PROCESSES FOR TCV COMPONENTS | BUDGET | 525 |
| 6 84 8442 | IMPROVED CUTTING OF CHARPY AND TENSILE BLANKS | APPORTIONMENT | 80 |
| E 79 3718 | AIR CYCLE AIR CONDITIONER COMPRESSOR- EXPANDER | UNFUNDED | 90 |
| E 83 3718 | AIR CYCLE AIR CONDITIONER COMPRESSOR EXPANDER | UNFUNDED | 315 |
| E 84 3718 | ADVANCED MFG TECH F/PRODUCING AIR CYCLE ECU COMPONENTS | APPORTIONMENT | 336 |
| E 85 3718 | ADVANCED MFG TECH F/PRODUCING AIR CYCLE ECU COMPONENTS | BUDGET | 240 |

SUBTASK NO. 4 6095-05
84/02/27.

| EFFORT NO | SUB TASK | SUBTASK TITLE |
|---|---|---|
| * 4 | 6095 05 | ABRAMS TRANSMISSION PRODUCTIVITY IMPROVEMENTS (PHASE II) |

PROBLEM AND SOLUTION

* PROBLEM - REPLACE TRADITIONAL HOBBING PROCESSES WITH NEW METHODS TO REDUCE COSTS AND PRODUCE GEARS TO HIGHER TOLERANCES AND BETTER SURFACE FINISH.

* SOLUTION - USE A HOB WITH CARBIDE CUTTING TEETH THAT ALLOWS HOBBING AT FINISH HARDNESS, RESULTING IN IMPROVED SURFACE FINISH AND COST REDUCTION BY REDUCING OR ELIMINATING THE NEED FOR FINISH GRINDING OPERATIONS AFTER HEAT TREATING.

| EFFORT No | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 4 4009 | IMPROVED TRACK PIN GRINDING | 85 | 150 | BUDGET |

PROBLEM AND SOLUTION

PROBLEM - T142 TRACK PINS ARE GROUND TO SIZE WITH CONVENTIONAL GRINDING METHODS CAUSING SURFACE TENSILE RESIDUAL STRESSES. NEAR-SURFACE TENSILE RESIDUAL STRESSES ARE EVEN GREATER THAN THOSE FOUND ON THE SURFACE WHEN CONVENTIONAL GRINDING PARAMETERS ARE USED. SURFACE AND NEAR SURFACE TENSILE RESIDUAL STRESSES CAUSE EARLY TRACK PIN FAILURES.

SOLUTION - UPDATE PRESENT GRINDING PROCEDURES AND PARAMETERS TO PREVENT OR MINIMIZE SURFACE AND NEAR SURFACE TENSILE RESIDUAL STRESSES FROM BEING INDUCED INTO THE TRACK PIN IN THE GRINDING OPERATION.

EFFORT NO. 4380
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 5 4380 | ABRASIVE MACHINING IN PROJECTILE MANUFACTURING | 84 | 412 | BUDGET |
| | | 85 | 192 | BUDGET |

PROBLEM AND SOLUTION

PROBLEM - THE NEW GENERATION OF PROJECTILES ARE CURRENTLY MACHINED USING CONVENTIONAL PROCESSES. THESE PROJECTILES ARE CHARACTERIZED BY HIGH HARDNESS AND ARE MADE FROM ALLOY AND HIGH FRAGMENTATION STEELS. THE CONVENTIONAL METHODS OF MACHINING THESE HARD ALLOYS RESULT IN LONGER PROCESSING TIME THAN WITH CONVENTIONAL CARBON STEELS AND THEREFORE CAUSE AN ATTENDANT INCREASE IN MACHINING COST AND LOWER PRODUCTION RATES.

SOLUTION - ABRASIVE MACHINING TECHNIQUES CAN BE USED TO INCREASE METAL REMOVAL RATES, AND HAVE THE ADVANTAGE OF PRESENTING THOUSANDS, OR PERHAPS MILLIONS OF INDIVIDUAL TOOLCUTTING EDGES TO THE SURFACE BEING MACHINED INSTEAD OF ONLY ONE TOOL EDGE AS IN CONVENTIONAL MACHINING. THIS PROJECT WILL INVESTIGATE THE APPLICATION OF ABBRASIVE MACHINING TECHNIQUES TO THE NEW GENERATION OF ALLOY STEEL PROJECTILES AND WILL EXPLORE THE LATEST STATE OF THE ART TECHNIQUES IN ABRASIVE MACHINING.

APPROACH

DESCRIPTION OF WORK - FY83 - THE INDUSTRY BASE WILL BE SURVEYED TO DETERMINE THE OPERATING CHARACTERISTICS OF THE AVAILABLE EQUIPMENT AND THE CURRENT APPLIATIONS OF THE ABRASIVE MACHINING TECHNOLOGY. A CONTRACTOR WILL BE SELECTED TO DEMONSTRATE HOW THE APPLICABLE ABRASIVE MACHINING TECHNIQUES MAY BE ADAPTED TO PROJECTILE MANUFACTURE USING AS FORGED AND HEAT TREATED PROJECTILE SAMPLES FROM CURRENT PRODUCTION.

FY84 - THE CONTRACTOR SHALL BE REQUIRED TO DEMONSTRATE FULL MACHINE CAPABILITY OF ABRASIVE MACHINING TECHNIQUES AS APPLIED TO PROJECTILE MANUFACTURE. THIS EFFORT SHALL REQUIRE FABRICATION OF THE NECESSARY TOOLS, FIXTURES, ABRASIVE FORMS, ETC. REQUIRED FOR ABRASIVE MACHINING. THE REQUIREMENTS FOR THIS EQUIPMENT SHALL BE THEN DEFINED IN SUFFICIENT DETAIL TO PREPARE AN EQUIPMENT SPECIFICATION.

SUBTASK NO. 4 6D57 11
84/D2/17.

| EFFORT NO | SUB TASK | SUBTASK TITLE |
|---|---|---|
| 4 | 6057 11 | THERMAL ASSISTED MACHINING |

PROBLEM AND SOLUTION

PROBLEM - EFFECTIVE METAL REMOVAL (WITHIN TOLERANCES) AT LOW COST.
SOLUTION - THE APPLICATION OF LOCALIZED AND CONCENTRATED HEAT JUST AHEAD OF THE CUTTING TOOL IS RECEIVING INCREASED RECOGNITION AS A MEANS OF INCREASING METAL REMOVED RATES, IMPROVING PART QUALITY IN DIMENSIONAL TOLERANCE COMPLIANCE AND ACHIEVED SURFACE FINISHES, REDUCING COSTS, INCREASING TOOL LIFE, ETC., WHEN MACHINING EXTREMELY HARD AND DIFFICULT-TO-MACHINE STEEL ALLOYS. HEAT SOURCES THAT MAY BE EMPLOYED INCLUDE THOSE SUCH AS ELECTRON BEAM, LASER, PLASMA-ARC, ETC. THIS TASK WILL ESTABLISH THE MANUFACTURING TECHNOLOGY OF THERMAL ASSISTED MACHINING FOR MACHINING ARMOR STEEL COMPONENTS SPECIFICALLY, OD TURNING OPERATIONS, FACES AND EXTERNAL SURFACES FOR THE ABRAMS COMBAT VEHICLE.

APPROACH

DESCRIPTION OF WORK - PHASE I - ESTABLISH WHICH OF THE AVAILABLE THERMAL ASSISTED MACHINING TECHNIQUES IS MOST SUITABLE FOR THE ARMOR STEELS EMPLOYED ON COMBAT VEHICLES. THIS WILL BE ACCOMPLISHED BY SUBMITTING SAMPLES OF THE SAME ARMOR STEEL COMPONENT TO THE AVAILABLE THERMAL ASSISTED MACHINING TECHNIQUES AND EVALUATING ACHIEVED RESULTS IN METAL REMOVED RATES, COMPLIANCE WITH ESTABLISHED DIMENSIONAL TOLERANCES AND SURFACE FINISHES, CUTTING TOOL LIFE, AND RESULTING CHANGES, IF ANY, IN PHYSICAL AND/OR MECHANICAL PROPERTIES. DATA WILL BE EVALUATED FROM THE VIEWPOINTS OF OPTIMUM RESULTS IN PRODUCTION TIME SAVINGS, IMPROVEMENT/CONSISTENCY INPUT QUALITY RESULTING PHYSICAL/MECHANICAL PART CONDITION AND THERMAL SYSTEM APPLICABILITY TO EXISTING MACHINING FACILITIES AND EQUIPMENT.
PHASE II - ADAPT THE SELECTED THERMAL ASSISTED MACHINING SYSTEM TO ONE OR MORE ABRAMS TANK MACHINING APPLICATIONS TO SERVE AS A PROTOTYPE SYSTEM AND BE AVAILABLE FOR FULL SCALE TESTING OF THERMAL ASSISTED MACHINING ON A WIDE RANGE OF COMPONENTS FROM THE M1, M2, M3, ETC.
PHASE III - IMPLEMENT THE PROTOTYPE MACHINING SYSTEM INTO PRODUCTION FOR COMPONENTS FOR ABRAMS TANK. THE MACHINING SYSTEM USED IN PRODUCTION WILL BE MONITORED AND REPORTED FOR COST SAVINGS. PERFORMANCE REPORTS, DEMONSTRATIONS AND BRIEFINGS WILL BE USED TO WIDELY DISSEMINATE THIS APPLIED TECHNOLOGY AND ENCOURAGE FURTHER IMPLEMENTATION IN OTHER AREAS OF NEED.

EFFORT NO. 8543
83/11/17.

| | EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|---|
| * 6 | 8543 | SLIDE TABLE CLIMB CREEP FEED GRINDING | 85 | 78 | BUDGET |

PROBLEM AND SOLUTION

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* PROBLEM - BREECH BLOCKS ARE EXTREMELY COMPLEX AND DIFFICULT TO MACHINE, DUE TO THE CRITICAL TOLERANCES NEEDED FOR SIZE CONTRO
L REQUIRING ROUGHING AND FINISHING OPERATIONS THAT MUST, BE PRODUCED WITH HIGH SPEED STEEL CUTTERS. WHILE MANY OF THE FINISHI
* NG OPERATIONS ARE CURRENTLY BEING COMPLETED ON NC EQUIPMENT, THE ROUGHING IS BEING DONE ON CONVENTIONAL EQUIPMENT.

* SOLUTION - PRODUCE PROTOTYPE EQUIPMENT TO REDUCE THE COST OF MACHINING BREECH BLOCKS THROUGH THE APPLICATION OF CLIMB CREEP F
EED GRINDING. MACHINE THE FULL FORM OF EACH SIDE OF THE GUIDE RAILS OF SEVERAL (AT LEAST THREE) 105MM M68 BREECH BLOCKS IN ON
* E PASS OF THE GRINDING RAIL.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 4 4013 | IMPROVED MACHINING PROCESSES FOR TCV COMPONENTS | 85 | 525 | BUDGET |

PROBLEM AND SOLUTION

PROBLEM - CONVENTIONAL MACHINING OF DIFFICULT-TO-MACHINE TCV MATERIALS (HIGH HARD ARMORS OR ROLLED HOMOGENEOUS STEELS) IS VERY EXPENSIVE. RAPID TOOL WEAR, EVEN WITH SMALL DEPTH CUTS, RESULTS IN FREQUENT INTERRUPTIONS FOR TOOL REPLACEMENTS DURING MACHINING OPERATIONS.

SOLUTION - DETERMINE THE PARAMETERS FOR SELECTING AND SUCCESSFULLY APPLYING NONTRADITIONAL MACHINING PROCESSES. ESTABLISH THE PROCESSES USING N/C SYSTEM APPLICATION TO TCV COMPONENTS AND DEMONSTRATE THE PROCESS BY FABRICATING PROTOTYPE COMPONENTS TO VALIDATE THE PROCESSES.

EFFORT NO. 8442
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 8442 | IMPROVED CUTTING OF CHARPY AND TENSILE BLANKS | 84 | 8D | APPORTIONMENT |

PROBLEM AND SOLUTION

PROBLEM - CANNON TUBE MATERIAL TEST SPECIMEN DISCS ARE MACHINED INTO CHARPY AND TENSILE BLANKS ON A SINGLE BLADE RECIPROCATING POWER HACKSAW. EACH BLANK IS CUT OUT IN SUCCESSIVE, INDIVIDUAL, TIME CONSUMING SAWING PASSES WHICH REQUIRES THE OPERATOR TO MANUALLY INDEX AND ALIGN EACH DISC AFTER EACH CUT, PRODUCING BLANKS THAT ARE INCONSISTENT, OVERSIZED NEEDING SUBSEQUENT MACHINING OPERATIONS TO PRODUCE FINAL SIZE.
SOLUTION - ADAPT HIGH SPEED CUTTING PROCEDURES WITH AUTOMATED WORKPIECE INDEXING AND HANDLING TECHNIQUES TO DECREASE MACHINING TIME AND ELIMINATE VARIOUS SUBSEQUENT MACHINING OPERATIONS.

APPROACH

DESCRIPTION OF WORK - FY84 - IN DEPTH ENGINEERING ANALYSIS OF HIGH SPEED METAL CUTTING TECHNOLOGIES AND AUTOMATION TECHNIQUES. RESULTS OF TESTING WILL BE USED TO SELECT THE OPTIMUM HIGH SPEED CUTTING METHOD. COMPLETE ENGINEERING PROCUREMENT SPECIFICATION PACKAGE OF ALL PROTOTYPE EQUIPMENT AND TOOLING WILL BE PREPARED.
FY 85 - PURCHASE, INSTALL AND TEST ALL PROTOTYPE EQUIPMENT NECESSARY TO MACHINE CHARPY AND TENSILE BLANKS FROM CANNON TUBE TEST SPECIMEN DISCS. 90 PERCENT OF THIS YEARS FUNDING WILL BE USED FOR EQUIPMENT ACQUISITION WHILE THE REMAINING FUNDING WILL SUPPORT IN-HOUSE ACTIVITIES, I.E., ENGINEERING, INSTALLATION AND ACCEPTANCE TESTING.
FY87 - CONCLUDE ALL THE PROJECT IN-HOUSE ACTIVITIES I.E., ENGINEERING TESTING, PRODUCTION APPLICATION AND PREPARATION OF FINAL TECHNICAL REPORT.

EFFORT NO. 3718
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 7 3718 | ADVANCED MFG TECH FOR PRODUCING AIR CYCLE ECU COMPONENTS | 84 | 336 | APPORTIONMENT |
| | | 85 | 240 | BUDGET |

PROBLEM AND SOLUTION

PROBLEM - THE COMPRESSOR AND EXPANDER ARE THE MAJOR CRITICAL COMPONENTS OF THE POSITIVE DISPLACEMENT AIR CYCLE ECU. TO REDUCE COST AND MEET THE REQUIRED SCHEDULE, A MANUFACTURING PROCESS FOR MASS PRODUCTION MUST BE DEVELOPED. THIS WORK IS IN SUPPORT OF AIR CYCLE DEVELOPMENT EFFORT REQUIRED BY LETTER OF AGREEMENT (LOA) FOR IMPROVED VAN AIR CLIMATE CONTROL SYSTEMS, TRADUC ACN 67158.

SOLUTION - ESTABLISH MANUFACTURING METHODS AND PROCESSES THAT WILL REDUCE COSTS OF PRODUCING AIR CYCLE COMPRESSORS AND EXPANDERS BY REDUCING ROTOR COMPLEXITY AND MAINTAINING CONCENTRICITY OF STATOR AND VANE CAM TRACK.

APPROACH

DESCRIPTION OF WORK - MANUFACTURING TECHNOLOGY WILL BE ESTABLISHED TO OPTIMIZE PRODUCTION OF THE SEGMENTED COMPRESSOR AND EXPANDER ROTORS THEREBY REDUCING THE NUMBER OF MACHINING AND FINISHING OPERATIONS WHILE MAINTAINING THE DESIGN DIMENSIONS AND QUALITY REQUIRED TO ENSURE THE HIGH EFFICIENCIES PRODUCED DURING THE DEVELOPMENT PHASE. IN LIKE MANNER, A MANUFACTURING TECHNIQUE MUST BE ESTABLISHED TO INSURE CONCENTRICITY OF THE COMPRESSOR/EXPANDER STATOR AND THE CAM TRACKS IN THE END PLATES. PRESENTLY, THESE SURFACES ARE SEPARATELY MACHINED AND EXTENSIVE HAND WORK IS REQUIRED TO MAKE A CONCENTRIC FIT. WORKING WITH THE DEVELOPER OF THIS PATENTED DESIGN, INDUSTRIAL MACHINE MANUFACTURERS WILL BE SOLICITED TO PROPOSE THEIR PROCESS PLANS BASED ON SPECIFICATIONS REQUIRING LOWEST FIRST COST AND HIGHEST OPERATIONAL EFFECTIVENESS. THESE PROPOSALS WILL BE EVALUATED WITH RESPECT TO COST/PERFORMANCE AND AT LEAST TWO MANUFACTURERS WILL BE AWARDED CONTRACTS TO FABRICATE A COMPRESSOR AND/OR EXPANDER. USING THE LATEST INDUSTRIAL TECHNOLOGY THIS NEW MANUFACTURING TECHNOLOGY WILL THEN BE TESTED FOR VERIFICATION OF PROPOSED PROCESSPLAN. THESE TESTS WILL INCLUDE CAPACITY, EFFICIENCY, AND ENDURANCE TO ESTABLISH RELIABILITY OF THE NEW AIR CYCLE COMPRESSOR/EXPANDER MANUFACTURING TECHNOLOGY.

## ADAPTIVE CONTROL PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 4 85 4016 | AUTOMATED THERMAL CUTTING OF ARMOR PLATE | BUDGET | 393 |
| 4 84 6121-03 | ADAPTIVE CONTROL AND CUTTING SENSING SYSTEMS | APPORTIONMENT | 350 |

## DIAGNOSTICS PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 6 85 8546 | MACHINERY CONDITIONS SURVEILLANCE SYSTEM | BUDGET | 350 |

## ELECTROCHEMICAL MACHINING PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 6 83 8225 | ELECTROCHEMICAL GRINDING OF WEAPON COMPONENTS | UNFUNDED | 130 |
| 6 84 8225 | ELECTROCHEMICAL GRINDING OF WEAPON COMPONENTS | APPORTIONMENT | 139 |
| 6 85 8544 | WIRE E.D.M. MACHINING OF RIFLING BROACHES | BUDGET | 91 |

## IMPROVED TOOLING PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 5 83 4535 | PRECISION TOOLING FOR SMALL CALIBER AMMUNITION | UNFUNDED | 210 |
| 5 84 4535 | PRECISION TOOLING FOR SMALL CALIBER AMMUNITION | BUDGET | 220 |
| 5 85 4535 | PRECISION TOOLING F/SMALL CALIBER AMMUNITION | BUDGET | 220 |
| 6 84 8449 | OPTIMAL RIFLING CONFIGURATION FOR CHROME PLATING | APPORTIONMENT | 228 |
| 6 85 8449 | OPTIMAL RIFLING CONFIGURATION FOR CR PLATING | BUDGET | 180 |
| 6 85 8542 | DIAMOND APPLICATION IN CANNON MFG | BUDGET | 125 |
| 6 85 8550 | BALANCED TOOL MACHINING | BUDGET | 70 |

## FLEXIBLE MANUFACTURING SYSTEM PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| G 85 7004 | AUTOMATED ENGINE BLOCK MACHINING | BUDGET | 730 |

| EFFORT No | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 4 4016 | AUTOMATED THERMAL CUTTING OF ARMOR PLATE | 85 | 393 | BUDGET |

PROBLEM AND SOLUTION

PROBLEM - PRESENT FLAME CUTTING PROCEDURES AND TECHNIQUES USED FOR FABRICATION OF M1 TANK ARMOR PLATE RESULT IN EXCESSIVE REWORK AND REPAIR REQUIREMENTS, POOR CYCLE TIMES, INEFFICIENT UTILIZATION OF EQUIPMENT AND MANPOWER, AND THE INABILITY TO SCHEDULE SUBSEQUENT WELDING OPERATIONS AT A FULLY ECONOMICAL RATE, DUE TO THE DIMENSIONAL INSTABILITY OF CUT PARTS.

SOLUTION - USE AN ADAPTIVE CONTROL SYSTEM TO MAINTAIN THE DIMENSIONAL STABILITY OF FLAME CUT ARMOR STEEL COMPONENTS. IT WILL MEASURE AND CORRECT FOR PLATE DISTORTION IN THREE DIMENSIONS AND IN REAL TIME. BASE PLATE POSITION AND CUT LOCATION WILL BE DETERMINED BY APPROPRIATE SENSORY TECHNIQUES AND CHECKED AGAINST THE MASTER ELECTRONIC TEMPLATE OF THE CUTTING SYSTEM. NECESSARY REAL TIME ADJUSTMENTS TO CUTTING HEAD POSITION WILL BE MADE BY AUTOMATED COMPENSATION DEVICES TO OFFSET ALL THERMAL MOVEMENTS.

SUBTASK NO. 4 6121 03
84/02/17.

| EFFORT NO | SUB TASK | SUBTASK TITLE |
|---|---|---|
| * 4 6121 03 | | ADAPTIVE CONTROL AND CUTTING SENSING SYSTEMS |

PROBLEM AND SOLUTION

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* PROBLEM - TOOL AND PART FEED RATES, OFTEN OBTAINED FROM HANDBOOKS, GENERAL MACHINE INSTRUCTIONS, MATERIALS SPECIFICATIONS OR OPERATOR EXPERIENCE, ARE FREQUENTLY NOT AT THEIR OPTIMUM FOR THE ACTUAL CONDITIONS EXISTING AT A PARTICULAR TIME IN PRODUCTIO
* N. THIS RESULTS IN DECREASED PRODUCTIVITY, POOR TOOL LIFE, INCREASED COST AND THE INABILITY TO CONSISTENTLY OBTAIN DESIRED SU
RFACE FINISH AND TOLERANCE.
* SOLUTION - THROUGH THE USE OF MICROCOMPUTER CONTROLS AND FEED BACK FROM SENSORS AT THE WORK PIECE, FEED/SPEED CAN BE OPTIMIZE
D AND MAXIMUM CUTTING PERFORMANCE ACHIEVED. IN ADDITION TO A GENERAL PROGRAM TO OPTIMIZE CUTTING PERFORMANCE, IT IS INTENDED
* TO EVALUATE SPECIFIC SENSING MECHANISMS WHICH HAVE BEEN DEVELOPED TO PREDICT IMMINENT BREAKDOWN OF DRILL BITS. CURRENT PROCED
URES FOR REPLACEMENT OF THESE TOOLS IS BASED ON OPERATOR EXPERIENCE AND OFTEN RESULTS IN EARLY REMOVAL OR FAILURE OF A TOOL I
* N PROCESS (WHICH LEADS TO SALVAGE AND REWORK OF PARTS).

APPROACH

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* DESCRIPTION OF WORK - VARIABLE SPEED DRIVES WILL BE ADDED TO CONVENTIONAL MACHINE TOOLS AND TRANSDUCERS AROUND THE TOOL WILL
PROVIDE FEEDBACK TO A MICROCOMPUTER/CONTROLLER. MACHINE OPERATORS WILL INPUT FINAL DIMENSIONS AND SURFACE FINISH REQUIRED AND
* MACHINING WILL BE SUPERVISED BY THE COMPUTER. ADAPTATION OF THE TOOLS WILL REQUIRE ESTABLISHMENT OF MOTORS AND CONTROL SYSTE
M HARDWARE AS WELL AS SOFTWARE TO CONTROL OPERATIONS AND PROCESS DATA. THE RESULTING BLACK BOX IS INTENDED TO BE RETROFIT INT
* O EXISTING MANUAL OR SEMI-AUTOMATIC MACHINE TOOLS. AFTER MODIFICATION, TOOLS WILL BE TESTED ON BATCHES OF PRODUCTION PARTS TO
DETERMINE MAXIMUM PRODUCTIVITY. IMPLEMENTATION WILL DEPEND ON THE ABILITY OF THE SYSTEM TO MEET OR EXCEED PRODUCTIVITY GOALS
* .
* SENSING MECHANISMS HAVE BEEN DEVELOPED WHICH OBTAIN INFORMATION TO PREDICT IMMINENT TOOL FAILURE. FOR EXAMPLE, THE NATIONAL B
UREAU OF STANDARDS HAS DEMONSTRATED A SYSTEM BASED ON ANALYSIS OF TOOL VIBRATION. CONCURRENT WITH ADAPTATION OF CONTROLS ON F
* EED/SPEED, POTENTIAL TOOL FAILURE DIAGNOSTIC MECHANISMS WILL BE EVALUATED FOR DRILL BITS. APPROPRIATE CONDIDATES WILL BE INST
ALLED ON EXISTING CNC MACHINES IN ORDER TO ARRIVE AT A SYSTEM WHICH CAN BE APPLIED TO THE PRODUCTION PROCESS.

| | EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|---|
| * 6 | 8546 | MACHINERY CONDITIONS SURVEILLANCE SYSTEM | 85 | 350 | BUDGET |

PROBLEM AND SOLUTION

PROBLEM - A NEED EXISTS FOR CONTINUOUS LARGE SCALE MONITORING OF MACHINE TOOL DYNAMICS AND THE TIMELY NOTIFICATION OF MANAGEMENT WHEN MECHANICAL MALFUNCTION ARE LIKELY TO OCCUR. THESE UNDETECTED CONDITIONS WOULD EVENTUALLY CAUSE THE MACHINE TOOLS AND ITS ASSOCIATED PRODUCTION FUNCTION TO BE SHUT DOWN.

SOULTION - INTRODUCTION OF A DYNAMIC ON-LINE DATA SYSTEM FOR MONITORING MACHINE TOOL VIBRATION SIGNATURE ANALYSIS AND OTHER SELECTED OPERATING PARAMETERS. PERMANENTLY INSTALL TRANSDUCERS ON SELECTED LARGE PRODUCTION MACHINE TOOLS AND TO TRANSFER EACH MACHINE S VIBRATION AND OPERATING PARAMETER SIGNALS TO A CENTRALLY LOCATED SYSTEM FOR ANALYSIS.

EFFORT NO. 8225
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 8225 | ELECTROCHEMICAL GRINDING OF WEAPON COMPONENTS | 84 | 139 | APPORTIONMENT |

PROBLEM AND SOLUTION

PROBLEM - SIZING AND FINISHING OF LARGE, LONG WEAPON COMPONENTS BY CONVENTIONAL GRINDING IS SLOW AND COSTLY, OFTEN REQUIRING MULTIPLE OPERATIONS, SET-UPS, WHEEL CHANGES AND REPETITIVE MULTIPLE PASSES.
SOLUTION - IN THIS ONE-YEAR EFFORT, AN EXISTING SURFACE GRINDER WILL BE RETROFITTED WITH AN ELECTROLYTIC GRINDING SYSTEM TO PROVIDE FAST, SINGLE-PASS ROUGHING AND FINISHING OF LARGE COMPONENTS, CONSEQUENTLY, ROUGHING BY PLANING OR MILLING BEFORE ELECTROLYTIC GRINDING WILL BE ELIMINATED.

APPROACH

DESCRIPTION OF WORK - THIS IS A ONE-YEAR PROJECT IN WHICH A SCOPE OF WORK WILL BE PREPARED AND A CONTRACT AWARDED TO CONVERT AN EXISTING, CONVENTIONAL LONG-BED HORIZONTAL SURFACE GRINDER TO AN ELECTROCHEMICAL GRINDING (ECG) SYSTEM. THIS CONVERSION WILL BE MADE FOR SPECIFICALLY GRINDING CHROME-PLATED, GUN-MOUNT RAILS, AND WILL INCLUDE REBUILDING OF THE GRINDER WAYS AND SPINDLE AS NECESSARY FOR ACCURACY AND ELECTRICAL CHARGING AND INSULATION. EXISTING FIXTURING WILL BE REPLACED, NOT ONLY FOR INSULATION, BUT ALSO, TO IMPROVE WORKPIECE LOADING, ALIGNMENT, CLAMPING AND UNLOADING. THE GRINDER WILL BE RETROFITTED WITH ELECTROLYTE, CONTROL, AND CUTTING WHEEL ASSEMBLIES TO COMPLETE THE RETROFIT CONVERSION FOR ECG. PRODUCTION WORKPIECES WILL BE TEST GROUND AT THE CONTRACTOR?S PLANT FOR ACCEPTANCE OF ACCURACIES AND MACHINING PARAMETERS. INSTALLATION, STARTUP AND PRODUCTION PROCEDURES WILL INCLUDE TRAINING OF MAINTENANCE AND PRODUCTION PERSONNEL. ALL WORK WILL BE COORDINATED WITH ENGINEERING DESIGN, PRODUCTION PLANNING, OPERATIONS, AND QUALITY ASSURANCE PERSONNEL, AND, A TECHNICAL REPORT WILL BE WRITTEN AND DISTRIBUTED ACCORDINGLY.

EFFORT NO. 8544
83/11/17.

| EFFORT No | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 8544 | WIRE E.D.M. MACHINING OF RIFLING BROACHES | 85 | 91 | BUDGET |

PROBLEM AND SOLUTION

PROBLEM - THE TEETH ON BROACH CUTTERS ARE PRESENTLY FORMED BY PLUNGE GRINDING THE MATERIAL OUT BETWEEN THE TEETH. NEW INNOVATIONS HAVE BEEN INTRODUCED TO SHORTEN GRINDING TIME, BUT CAN ONLY BE USED FOR ROUGHING OPERATIONS. FINISHING IS DONE BY FORMING STANDARD ALUMINUM OXIDE WHEELS AND GRINDING THE BROACH TEETH ON THESE FORMS. THE WHEELS BREAK DOWN AND FREQUENTLY MUST BE DRESSED TO RESUME THE PROPER FORM. THE REMOVAL OF STOCK BY PLUNGE GRINDING CREATES A GREAT DEAL OF HEAT AND HAS AN ADVERSE EFFECT ON THE HARDNESS OF THE CUTTING EDGES, RESULTING IN RAPID DULLING OF THESE EDGES. FREQUENT RESHARPENINGS REDUCE THE LIFE OF THE BROACHES.

SOLUTION - FORM THE BROACH TEETH BY UTILIZING WIRE ELECTRICAL DISCHANGE MACHINING WITH C.N.C. CONTROLS. REMOVE THE MATERIAL BETWEEN EACH TOOTH IN ONE PIECE BY THE ELECTRODE WIRE PASSING THROUGHOUT THE PERIMETER OF THE CUTOUT. THIS WILL DRASTICALLY REDUCE BROACH MANUFACTURING TIME AND REDUCE THE DAMAGING HEAT EFFECTS OF PLUNGE GRINDING.

EFFORT NO. 4535
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 5 4535 | PRECISION TOOLING FOR SMALL CALIBER AMMUNITION | 84 | 220 | BUDGET |
| | | 85 | 220 | BUDGET |

PROBLEM AND SOLUTION

PROBLEM - MOST OF THE TOOLING DESIGNS CURRENTLY USED BY SMALL ARMS AMMUNITION MANUFACTURERS FOR CASE DRAWING AND BULLET FORMING OPERATIONS WERE DEVELOPED 20 OR MORE YEARS AGO. AS A RESULT, MANY OF THE DESIGNS ARE NOT UTILIZING THE LATEST TECHNOLOGY IN MATERIALS AND METHODS FOR FABRICATING DIES AND PUNCHES. FOR EXAMPLE, WHILE MANY DIES ARE MADE FROM P/M (POWDER METALLURGY) TUNGSTEN CARBIDE, THE MANUFACTURERS HAVE NOT TAKEN ADVANTAGE OF THE NEW P/M TOOL STEELS WHICH OFFER IMPROVED GRINDABILITY AND LONGER TOOL LIFE. CHANGES IN DRAW DIE CONTOUR NORMALLY HAVE GENEROUS RADII WHICH ARE FINISHED BY HAND. RECENTLY DEVELOPED TOOLING CONCEPTS BY THE CANNING INDUSTRY CAN ELIMINATE THE NEED FOR THE GENEROUS RADII AND INCREASE THE DIMENSIONAL UNIFORMITY OF THE TOOLING. DOWNTIME FOR REPLACEMENT/SETTING OF TOOLS IS ALSO A SIGNIFICANT FACTOR IN THE COST OF PRODUCING AMMUNITION. THUS, A DECREASE IN TOOL FABRICATION COSTS AND AN INCREASE IN TOOL LIFE WOULD BE A SIGNIFICANT FACTOR IN LOWERING AMMUNITION PRODUCTION COSTS.

SOLUTION - P/M NEAR-NET-SHAPE TOOL BLANKS, AND TOOL DESIGNS AND FINISHING CONCEPTS PROVEN IN THE CANNING INDUSTRY WILL BE UTILIZED TO FABRICATE TOOLING FOR PRODUCING SMALL CALIBER AMMUNITION. P/M PRODUCED TOOL BLANKS WILL BE USED BECAUSE THEY HAVE FREEDOM FROM CARBIDE SEGREGATION WHICH PROVIDES FOR EVEN AND PREDICTABLE DIMENSIONAL CHANGE ON HEAT TREATMENT, IMPROVED GRINDABILITY AND HIGH WEAR RESISTANCE. TOOL BLANKS WILL BE FABRICATED TO NEAR-NET-SHAPE TO REDUCE THE AMOUNT OF MACHINING AND FINAL GRINDING. FOLLOWING THE CANNING INDUSTRY, TOOLING DESIGNS WILL BE MODIFIED TO ELIMINATE DIE BLEND RADII WHICH ARE HAND FINISHED AND REQUIRED HIGH SURFACE FINISHES AND TIGHTER TOLERANCES. INSPECTION PROCEDURES WILL BE DEVELOPED THAT CAN PROVIDE A GRAPHICAL RECORD OF TOOL CONTOUR DURING ITS LIFE CYCLE. TOOLING PRODUCED BY THESE TECHNIQUES WILL BE EVALUATED IN A PRODUCTION ENVIRONMENT.

APPROACH

DESCRIPTION OF WORK - THIS PROJECT IS PLANNED AS A TWO YEAR EFFORT DIRECTED TOWARD DEVELOPING NEW SPECIFICATIONS AND AUTOMATED INSPECTION PROCEDURES FOR SMALL AND CANNON CALIBER AMMUNITION PRODUCTION TOOLING. FY83 - NEGOTIATE A CONTRACT WITH LAKE CITY ARMY AMMUNITION PLANT TO FABRICATE PROTOTYPE TOOL SETS FOR EIGHT DIFFERENT OPERATIONS USED IN PRODUCING 5.56MM AMMUNITION ON THE SCAMP LINES-INITIAL CASE DRAW, FINAL CASE DRAW, CASE HEADING, CASE VENTING, BULLET DRAW, BULLET SECOND POINT, BULLET FIRST BOATTAIL AND BULLET SECOND BOATTAIL. PRESENT TOOL DRAWINGS WILL BE MODIFIED TO INCORPURATE TECHNOLOGY DEVELOPED BY THE CANNING INDUSTRY, SUCH AS, THE USE OF CHAMFERS AND SHARP EDGES IN PLACE OF DIE BLENDS AND THE USE OF TIGHTER TOOLING TOLERANCES. PROTOTYPE PUNCH BLANKS WILL BE FABRICATED BY TWO DIFFERENT POWDER METALLURGY METHODS-HOT ISOSTATIC PRESSING AND THE FULDENS PROCESS AND BY MACHINING FROM WROUGHT STOCK FOR COMPARISUN PURPOSES. TOOLING BLANKS WILL BE FINISHED TO SIZE BY NC GRINDING TO HAVE A HIGH SURFACE FINISH.

FY84 - DEVELOP AN AUTOMATED INSPECTION PROCEDURE FUR THE TOOLING WHICH CAN PROVIDE A GRAPHICAL RECORD OF THE TOOLING PROFILE. AFTER INSPECTION, TEST TOOLING PRODUCTIUN SIMULATORS AT ARRADCOM TU MEASURE PERFORMANCE UNDER IDEAL CONDITIONS. THIS WILL BE FOLLOWED BY PROVE-OUT RUNS OF THE TOOLING UNDER ACTUAL PRODUCTION CONDITIONS AT LAKE CITY ARMY AMMUNITION PLANT. THE RESULTS OF THE TESTS, INSPECTIUN AND PROVE-OUT RUNS WILL BE USED TO DEVELOP NEW TOOLING SPECIFICATIONS, AN INSPECTIUN PROCEDURE USING THE AUTOMATED EQUIPMENT AND A TECHNICAL REPURT DESCRIBING THE TOOLING DESIGN, FABRICATION, LIFE EXPECTANCY AND COSTS.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 8449 | OPTIMAL RIFLING CONFIGURATION FOR CHROME PLATING | 84 | 228 | APPORTIONMENT |
| | | 85 | 180 | BUDGET |

PROBLEM AND SOLUTION

PROBLEM - EARLY FAILURE OF CHROMIUM COATINGS IN GUN TUBES OCCURS AT THE SHARP CORNERS OF THE LAND RUN-UP. THESE SHARP CORNERS FORMED DURING LAND-GROOVE BROACHINGS ARE DIFFICULT TO MODIFY. PRESENTLY NO EFFECTIVE METHOD OR TOOL IS AVAILABLE TO ELIMINATE THIS CONDITION AND THE SUSCEPTIBILITY TO EARLY CHROME FAILURE CONTINUES.

SOLUTION - THE DEVELOPMENT OF A MECHANICAL DEVICE TO MODIFY THE LAND EDGES WAS ACCOMPLISHED UNDER ILIR STUDIES. THIS TECHNIQUE AND ACCOMPANYING POWER TOOL WILL BE USED TO ALTER THE RIFLING PROFILE AND AN INCREASE IN EFFECTIVE WEAR LIFE OF THE CHROMIUM DEPOSITS WILL BE THE RESULT.

APPROACH

DESCRIPTION OF WORK - FY84 - DESIGN AND CONSTRUCTION OF ONE OR A SERIES OF POWER TOOLS DIMENSIONED FOR A SPECIFIC TUBE AND THE ESTABLISHMENT OF A METHOD TO PRODUCE AN ACCEPTABLE RIFLING PROFILE AND SURFACE FINISH WHICH WOULD BE APPLICABLE TO ALL RIFLED GUN TUBES WHICH REQUIRE CHROMIUM PLATING. TWO OR MORE DESIGN CONCEPTS WILL BE CONSIDERED AND THE OPERATING LIMITS OF THE PROCESS PARAMETERS SUCH AS SPEEDS, PRESSURE, AND TYPES OF ABRASIVES OR CUTTING EDGES WILL BE DETERMINED. THE EARLY TRIAL RUNS WILL BE APPLIED TO SHORT TEST CYLINDERS WHICH WILL HAVE THE ORIGIN OF RIFLING DIMENSIONED TO THE DRAWING SPECIFICATIONS OF A STANDARD TUBE. THE FINAL APPLICATION WILL BE APPLIED TO A PRACTICE FULL LENGTH RIFLED TUBE.

FY85 - NECESSARY MODIFICATIONS TO THE DESIGN OF THE POWER TOOL TO REFINE THE OPERATION OF ALTERING THE RIFLING PROFILE IN FULL LENGTH TUBES. TRAIN PRODUCTION PERSONNEL TO OPERATE THE TOOL FOR OPTIMUM RIFLING CONTOUR IN A RIFLED FULL LENGTH TUBE WHICH CAN BE USED FOR TEST FIRING TO DETERMINE SERVICE LIFE INCREASE. THE COST OF THE TUBES IS INCLUDED IN THE PROJECT COST.

EFFORT NO. 8542
83/11/17.

| | EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|---|
| * 6 | 8542 | DIAMOND APPLICATION IN CANNON MFG | 85 | 125 | BUDGET |

PROBLEM AND SOLUTION

* PROBLEM - VARIOUS CANNON AND RELATED COMPONENTS THAT HAVE FINE SURFACE FINISH REQUIREMENTS ARE MACHINED BY AT LEAST TWO MACHINING OPERATIONS. THESE COMPONENTS ARE FIRST SEMI-FINISHED MACHINED, THEN TRANSFERRED WHERE THEY ARE FINISH GROUND SO THAT THE SPECIFIED DRAWING SIZE AND SURFACE FINISH ARE MAINTAINED. THIS DOUBLE OPERATION IS COSTLY TO THE MANUFACTURING PROCESS AND STIPULATES TWO FOLD RELATED TOOLING.

* SOLUTION - COMBINE INTO THE SEMIFINISH OPERATION A DIAMOND BURNISHING CONCEPT. THIS ARRANGEMENT WILL POSSESS THE NECESSARY TOOLING CAPABLE OF GENERATING THE COMPONENT SPECIFIED SURFACE FINISH AT ITS DRAWING DIMENSIONS.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 8550 | BALANCED TOOL MACHINING | 85 | 70 | BUDGET |

PROBLEM AND SOLUTION

PROBLEM - IN MACHINING LONG WORK PIECES SUCH AS THE 105MM M68 GUN TUBES, PRESENT PRACTICE USES STEADY REST SUPPORTS TO HOLD THE TUBE TO FACILITATE MACHINING THE O.D. THE STEADY REST ACTS AS A RESTRAINT MECHANISM NOT ALLOWING NATURAL DISTORTIONS OF THE WORKPIECE TO OCCUR. THE DISTORTIONS ARE BROUGHT ABOUT BY TOOL CUTTING FORCES TENDING TO FORCE THE TUBE REARWARD. WHEN THE TUBE IS LOOSENED FROM THE STEADY REST AFTER MACHINING IS COMPLETED, THE FORCES CONTAINED BY THE STEADY REST ARE RELEASED RESULTING IN A BENT TUBE.

SOLUTION - BY APPLYING BALANCED TOOLS OPPOSITELY POSITIONED, THE CUTTING FORCES GENERATED BY EACH TOOL WILL BE BALANCED BY EACH OTHER RESULTING IN MINIMAL TUBE DEFLECTION AND ELIMINATING THE NEED OF CONVENTIONAL STEADY REST SUPPORT MACHINING. AN AUTOMATIC LOAD ADJUSTING FOLLOWER REST WILL BE INSTALLED TO COMPENSATE FOR TUBE SAG.

EFFORT NO. 7004
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| * G 7004 | AUTOMATED ENGINE BLOCK MACHINING | 85 | 730 | BUDGET |

PROBLEM AND SOLUTION

*
* PROBLEM - THE CURRENT METHOD OF MACHINING AND INSPECTION OF ENGINE BLOCKS IS ANTIQUATED, SLOW AND LABOR INTENSIVE. BORING BARS ARE SET UP FOR EACH HOLE TO BE MACHINED AND ALL INSPECTION IS DONE BY HAND.
* SOLUTION - ESTABLISH AN AUTOMATED ENGINE BLOCK MACHINING SYSTEM FOR OVERHAUL APPLICATIONS BY DEVELOPING REQUIRED CAPABILITIES, PREPARE CONTRACT FOR BID AND EVALUATE CONTRACTORS PROPOSALS. INSTALL THE SYSTEM AND PREPARE TECHNICAL REPORTS AND SOPS.

## INTEGRATED MANUFACTURING SYSTEM PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 6 85 8132 | PERFORMANCE MEASUREMENT FOR GOGO MFG (CAM) | BUDGET | 250 |
| 6 85 8559 | CIM FOR CANNON CAD/CAM/COMM | BUDGET | 1160 |

## ROBOTICS PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| G 85 2004 | PROTOTYPE ROBOT AUGMENTED COMPUTERIZED LASER GRAPHICS ENGRAV | BUDGET | 398 |
| 1 84 7477 | UNMANNED MACHINING CELL | APPORTIONMENT | 100 |
| 6 85 8702 | ROBOT APPLICATION IN BATCH MFG (CAM) | BUDGET | 350 |

## CUTTING FLUID DATA PROJECTS

| PROJECT NUMBER | TITLE | CYCLE | PROJECT COST |
|---|---|---|---|
| 6 85 8516 | COMPOUNDING OF CUTTING FLUIDS + OILS FOR PRODUCTION | BUDGET | 144 |

EFFORT NO. 8132
83/12/09.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| 6 8132 | PERFORMANCE MEASUREMENT PARAMETERS FOR GOGO MFG. | 85 | 250 | BUDGET |

PROBLEM AND SOLUTION

PROBLEM - ROCK ISLAND ARSENALS (RIAS) MANUFACTURING OPERATION IS UNDERGOING SIGNIFICANT CHANGES, INCLUDING NEW EQUIPMENT AND FACILITIES AND INCREASED APPLICATION OF COMPUTER SYSTEMS FOR PRODUCTION SCHEDULING, FACTORY COMMUNICATION, PROCESS PLANNING, ETC. THE IMPACT OF THESE CHANGES IS DIFFICULT TO PROJECT WITHOUT A CONSISTENT SET OF OVERALL MANUFACTURING PERFORMANCE MEASUREMENTS.

SOLUTION - DEVELOP A SET OF PERFORMANCE MEASUREMENTS FOR RIAS GOGO MANUFACTURING OPERATION THAT TAKES INTO ACCOUNT THE PECULIARITIES OF GOGO OPERATIONS AND ALSO UTILIZES THE INCREASING AMOUNT OF COMPUTERIZED MANUFACTURING DATA BEING COLLECTED. THE MEASUREMENTS WILL BE DEVELOPED IN THREE STEPS. FIRST, HISTORICAL DATA SUCH AS PAST PRODUCTION SCHEDULES AND COSTS, MMT PROJECTS AND IMPLEMENTATION REPORTS, ACCOUNTING AND BUDGETING DATA, ETC., WILL BE COLLECTED AND DOCUMENTED. NEXT, THE AVAILABLE DATA, EXISTING PERFORMANCE MEASUREMENTS, AND NEEDS PERCEIVED BY MANUFACTURING MANAGERS WILL BE ANALYZED. FINALLY, THE PROCEDURES FOR MAINTAINING AND UTILIZING A SELECTED SET OF OVERALL MANUFACTURING PERFORMANCE MEASUREMENTS WILL BE DEVELOPED.

EFFORT NO. 8559
83/11/17.

| | EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|---|
| * 6 | 8559 | CIM FOR CANNON CAD/CAM/COMM | 85 | 1160 | BUDGET |

PROBLEM AND SOLUTION

PROBLEM - PROJECT REARM WILL PROVIDE THE MOST MODERN CANNON MAKING FACILITY IN THE WORLD AT WATERVLIET ARSENAL AND WITH IT, THE MOST ADVANCED COMPUTER AIDED MANUFACTURING TECHNOLOGIES AND EQUIPMENT, OF WHICH THE FLEXIBLE MANUFACTURING SYSTEM (FMS) WILL BE SETTING NEW INDUSTRY STANDARDS. THE ABSENCE OF INTEGRATED COMPUTER AIDED DESIGN AND ENGINEERING, TOGETHER WITH THE NECESSARY HIGH LEVEL PLANT WIDE COMMUNICATION NETWORK TO INTEGRATE ENGINEERING, MANUFACTURING AND BUSINESS SYSTEMS, PRESENTS SITUATION WHICH WILL JEOPARDIZE FULL CAPITALIZATION OF THE REARM PROGRAM. A ENGINEERING EFFORT TO FULLY CAPITALIZE ON AUTOMATION INVESTMENTS THROUGH THIS CAD/CAM COMM PROJECT IS NEEDED.

SOLUTION - INTRODUCE AND INTEGRATE COMPUTER AIDED DESIGN TECHNOLOGIES THROUGHOUT THE ENGINEERING, PRODUCT ASSURANCE AND MANUFACTURING ELEMENTS AT WATERVLIET ARSENAL AND BENET WEAPONS LABORATORIES AND INSTALL HIGH SPEED PLANT WIDE COMMUNICATIONS NETWORK TO BRIDGE EXISTING ISLANDS OF AUTOMATION.

EFFORT NO. 2004
83/11/17.

| EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|
| * G 2004 | PROTOTYPE ROBOT AUGMENTED COMPUTERIZED LASER GRAPHICS ENGRAV | 85 | 398 | BUDGET |

PROBLEM AND SOLUTION

* PROBLEM - THE CURRENT DEPOT ENGRAVING PROCESS IS MANUAL, TEDIOUS, AND RESTRICTIVE TO PROCESSING A FINITE RANGE OF MATERIALS. WITH THE DEVELOPMENT OF A ROBOTIC AUGMENTED COMPUTERIZED LASER ENGRAVING SYSTEM, PRODUCTIVITY, PART QUALITY AND TOOLING REQUI
* REMENTS CAN BE ENHANCED. LEAD WILL BEGIN PROCESSING ALL PRIMARY AND SECONDARY COMPONENTS COMMENCING IN EARLY FY87.

* SOLUTION - PROCURE A SYSTEM COMBINING THE TECHNOLOGIES OF COMPUTERIZED LASER ENGRAVING GRAPHICS AND ROBOTICS TO INCREASE ENGR AVING CAPABILITIES AND RESULT IN AN INCREASE IN PRODUCTIVITY OF APPROXIMATELY 60 - 80 PERCENT FOR PROCESSING COMPONENTS.

EFFORT NO. 7477
83/11/17.

| | EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|---|
| * 1 | 7477 | UNMANNED MACHINING CELL | 84 | 100 | APPORTIONMENT |

PROBLEM AND SOLUTION

***

* PROBLEM - NUMERICALLY CONTROLLED MACHINE TOOLS ARE UTILIZED IN THE MACHINING OF HIGH-TEMPERATURE ALLOY PARTS FOR GAS TURBINE ENGINES AND ARE LABOR INTENSIVE AND AND VERY COMPLEX IN TERMS OF MATERIALS MOVEMENT AND HANDLING LOGISTICS, SCHEDULING AND IN
* VENTORY MANAGEMENT, PRODUCT QUALITY ASSURANCE AND TOTAL SYSTEM PROCESS CONTROL.

* SOLUTION - ESTABLISH AN UNMANNED MACHINING CELL INCORPORATING ROBOTICS, ADAPTIVE CONTROL, AUTOMATIC GAGING, AUTOMATED MATERIA L HANDLING, AND NUMERICALLY CONTROLLED MACHINE TOOLS IN A SPECIFIC MANUFACTURING AREA.

APPROACH

***

* DESCRIPTION OF WORK - NOT PROVIDED.

EFFORT NO. 8702
83/11/17.

| | EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|---|
| * 6 | 8702 | ROBOT APPLICATION IN BATCH MFG (CAM) | 85 | 350 | BUDGET |

PROBLEM AND SOLUTION

* PROBLEM - ROCK ISLAND ARSENAL HAS MANY POTENTIAL COST SAVING ROBOT APPLICATIONS WITHIN ITS MANUFACTURING OPERATION, INCLUDING - MACHINE LOADING, FORGING, PAINTING, CASTING, DRILLING, GRINDING, DEBURRING, AND ASSEMBLING. DETERMINING WHETHER A ROBOT CAN
* EFFECTIVELY PERFORM A SPECIFIC OPERATION AND THEN DESIGN AND INSTALL THE ROBOT SYSTEM, REQUIRING SPECIALIZED KNOWLEDGE AND C APABILITY.
* SOLUTION - EXAMINE ALL OF RIA POTENTIAL ROBOT APPLICATION AREAS AND SELECT THE MOST PROMISING APPLICATIONS FOR DEVELOPMENT AN D INSTALLATION. PROVIDE NOT ONLY WORKING, COST SAVING EXAMPLES OF ROBOT APPLICATIONS, BUT ALSO THE DOCUMENTATION, KNOWLEDGE,
* AND EXPERIENCE TO PROCEED WITH FURTHER ROBOT APPLICATIONS.

EFFORT NO. 8516
83/11/17.

| | EFFORT NO | TITLE | FY | COST | STATUS |
|---|---|---|---|---|---|
| * | 6 8516 | COMPOUNDING OF CUTTING FLUIDS + OILS FOR PRODUCTION | 85 | 144 | BUDGET |

PROBLEM AND SOLUTION

* PROBLEM - PRESENT MACHINING OPERATIONS USE PROPRIETARY CUTTING FLUIDS AND OILS, WITH UNKNOWN INGREDIENTS. WHEN ADDITIONS ARE REQUIRED, FLUID FROM THE SAME SUPPLIER MUST BE USED TO ELIMINATE POTENTIAL PROBLEMS OF INCOMPATIBILITY. IT IS NOT ECONOMICALLY FEASIBLE TO CLEAN OUT ALL MACHINES JUST TO USE A FLUID FROM A DIFFERENT SUPPLIER. THUS, ACQUISITON OF CUTTING FLUIDS AND OILS BY SOLE SOURCE PROCUREMENT IS REQUIRED, CONTRARY TO COMPETITIVE PROCUREMENT.
* SOLUTION - IT IS PROPOSED THAT SOLE SOURCE PROCUREMENT BE MINIMIZED BY ELIMINATING THE USE OF PROPRIETARY CUTTING FLUIDS AND OILS. THE NECESSARY TEST EQUIPMENT TO COMPOUND FLUIDS AND OILS AT RIA WILL BE PROCURED TO ASSURE QUALITY CONTROL AND IMMEDIATE AVAILABILITY OF THE COMPOUNDED MATERIALS.

# APPENDIX H

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